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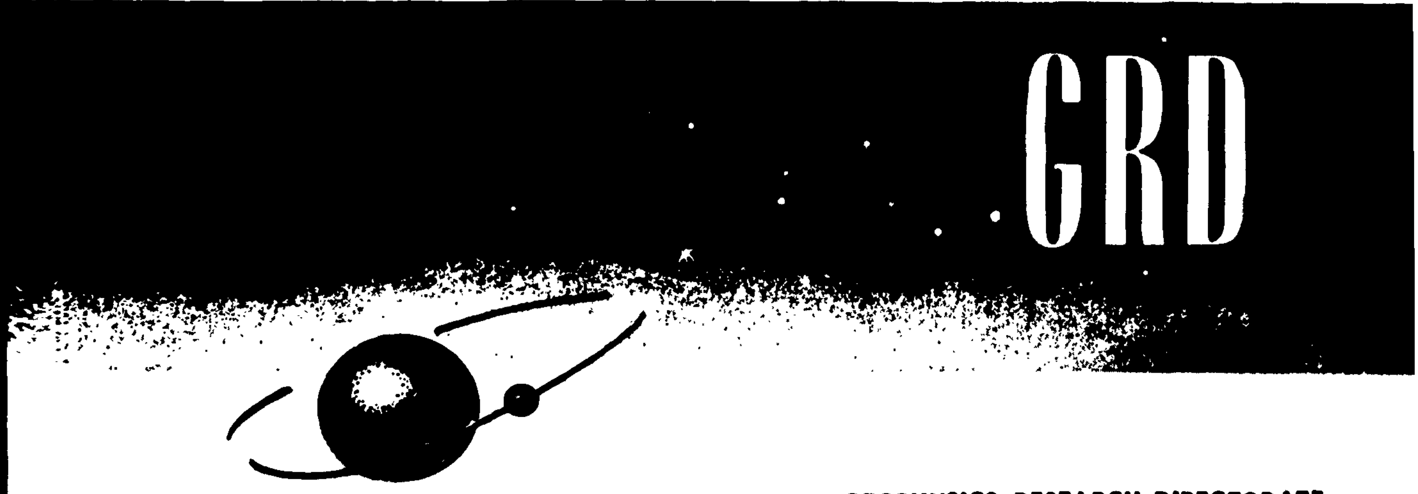

GEOPHYSICS RESEARCH DIRECTORATE
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ABSTRACT

The Sacramento Peak flare observations provide an ideal sample of data with which to study the distribution of solar flare areas and the effects of geometric projection upon the area. A flare's area is significant chiefly as a measure of its importance as a source of corpuscular emission and hard radiation. The present international convention of assigning importance is criticized, and some proposals to improve this convention are commented upon. The principal difficulty lies in the method of correcting the apparent area of a flare for geometrical foreshortening when the flare is not situated at the center of the solar disk. The majority of flares have some extension in height which is not negligible in comparison to their extension the tangential plane. Therefore an area correction which is simply the secant of the central distance angle will exaggerate the importance of flares near the limb.

We have examined the statistical properties of the areas of 7500 flares and subflares in order to test other correction procedures, which take into account the sensible heights of flares. Our criterion of any area rectification process is that it should render the area frequency function of flares invariant with central distance. One procedure, which was devised by C. S. Warwick and has been adopted by several American observatories, proves to be very successful. However no objective formula can recover the area of a partially occulted flare right at the sun's limb. For such events an experienced observer's judgement is probably the best guide to a flare's importance.

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A STUDY OF SACRAMENTO PEAK FLARES. II: FLARE AREAS AND IMPORTANCE CLASSIFICATIONS

1. Introduction

The most frequently employed measure of a chromospheric flare's size, intensity or energy is its importance. Importance has become a popular characteristic of flares, especially in statistical correlation analyses, even though it is known to be beset with grave faults as a quantitative specification of almost any measurable property of a flare. Originally it was meant as a substitute for the qualitative, subjective estimate of "small", "medium" or "large", in terms of whatever single physical parameter each observer had to deal with (I. A. U. Quarterly Bulletin No. 45). Long ago M. Waldmeier (Zs. f. Ap., 16, 1938), M. A. Ellison (M. N. R. A. S., 109, 3, 1949) and others established a reasonable correlation between importance and area. By action of Subcommission 11a of the International Astronomical Union (Transactions, 9, 146, 1956), the area limits set forth in Table 1 were adopted as the definition of importance classes. In addition, subclasses 1+ and 2+ were proposed to account for flares which appear unusually bright or unusually faint (either central intensity or total width of the Hα line) for the norm of their area classes. (Subclasses 2- and 3- were forbidden; their infrequent and inconsistent use merely reflects the tendency of human beings to overrefine a simple trinary classification system.)

We should note that there has been considerable confusion about the unit of area. In this report, we shall speak exclusively of areas in millionths of the solar hemisphere, such that one square degree of heliographic coordinates equals 48.5 millionths. Occasionally observers speak loosely of "millionths of the disk", meaning millionths of the hemisphere. Such practise is deplorable, as it has misled several workers into incorrect interpretation of their observational results.

From the earliest statistical studies (Waldmeier 1938) of the distribution of flares on the sun's disk, it was recognized that the number and mean importance of flares decreased with increasing distance from the center. This effect can be clearly seen in Figure 1, which shows the center-limb variation of flare incidence, in 3 area classes, for 4227 flares observed at Sacramento Peak (H. J. Smith, SPO Solar Res. Note No. 3, 1959). (The zone 80-90 degrees in this figure also includes flares at or above the limb.) This observed visibility function is attributed to geometric foreshortening of apparent flare areas: flares appear to be flat, with relatively little vertical height compared to their lateral dimensions. Observations at oblique incidence do indeed confirm this. To eliminate this effect in flare importance classification, it is the practise of some observers --

as well as the recommendation of the Working Group of Subcommission lla of the I.A.U. -- to apply a foreshortening correction to the area, before using the limits of Table 1 to assign importance. Up to this point no reasonable critic would disagree. However, the Working Committee suggests a correction formula

$$A_c = \frac{A_m}{\cos \phi} \tag{1}$$

when A_c and A_m are the corrected and measured areas, and ϕ the heliocentric distance angle. (The radius vector R, is the sine of this angle.) This recommendation is absurd for two reasons: (a) the correction factor $C(\phi) = \sec \phi$ becomes infinite at the limb, and so large even at distances $\phi > 50$ degrees, that nobody uses it; (b) the secant correction assumes that flares have no height whatsoever, even though it has long been recognized that this is contrary to fact (Ellison 1949; C.S. Warwick 1955, Ap. J., 121, 385; J. W. Warwick 1955, Ap. J., 121, 376; R. Giovanelli and Mc Cabe 1958, Aus. J. Phys., 11, 130; C. S. Warwick and M. Wood 1959, Ap. J., 801).

How, then, should an observer correct the measured area of a flare before assigning an importance classification? Faced by this grave problem, some observatories have applied the sec ϕ correction exactly up to some limiting heliocentric distance, then arbitrarily moderate it for greater values of ϕ. Other observers have preferred to avoid this erroneous and arbitrary procedure, and use only the measured area for classification. But this decision has proved equally wrong, for it results in gross underestimates of importances near the limb.

2. "Realistic" Projection Corrections

Two proposals have been made to correct this situation. M. C. Ballario (1960) has analyzed the foreshortening correction systems, as were applied to 2581 flares reported in the CRPL F-Series, Part B, by the following observatories: Capri, Zurich, Hawaii, McMath, Mitaka, USNRL and Arcetri. These observatories publish both A_m and A_c, and "generally adhere to the IAU scale of importance." Thus Ballario's results should reliably demonstrate the correction system actually used. Assuming that the mean area in each importance class should be invariant with position on the disk, she derived a projection corrective function $C_B(\phi)$ which is reproduced here as Table 2. Up to radius vector 0.75, $C_B(\phi)$ follows the secant law (1); at greater heliocentric distances, the deduced projection correction increases more slowly than sec ϕ, up to a limit of about 4.8 at the limb (cf. Fig. 2). Ballario found that the observatories she studied generally followed the secant law up to 50-60 degrees, but a smaller correction out to the limb. Compared to $C_B(\phi)$, she concluded that "generally speaking, this correction was still too high."

To render importance classifications uniform at all observatories, and independent of position on the solar disk, Ballario has proposed that flare patrol stations omit any area correction for foreshortening, but rather refer the measured areas to a scale of importance area limits which is adjusted to heliocentric distance angle. She has calculated these limits, which we reproduce in abbreviated form in Table 3, on the basis of C_B (ϕ). As we shall show below, this correction (which was derived from a flare sample deficient in the smallest projected areas) tends to overcorrect small flares. Because it applies a maximum correction uniformly to all events, we can anticipate that its use on measured areas down to 10 millionths would fail to correctly compensate foreshortening.

C. S. Warwick (unpublished) independently arrived at a projection correction formula that is not greatly dissimilar to Ballario's:

$$C_W = \frac{1}{\cos \phi + 0.2 \sin \phi} = \frac{1}{(1 - R^2)^{1/2} + 0.2 R} \qquad (2)$$

This correction has been established in the following way. Consider a hypothetical flare, whose area when viewed at the limb is A_l, (lateral area), and at the center of the disk A_p (plan area). Now assume that this flare is a simply connected, convex domain of uniform height and bounded by vertical sides. (The last assumption is essentially true, and all others are false for many flares.) Then at heliocentric distance angle ϕ, the hypothetical flare will have an apparent area

$$A(\phi) = A_p \cos \phi + A_l \sin \phi$$

so that the area correction coefficient for this flare is

$$C\phi = \frac{A_p}{A(\phi)} = \frac{1}{\cos \phi + \frac{A_l}{A_p} \sin \phi} = \frac{1}{\cos \phi + k \sin \phi} \ .$$

C. S. Warwick has evaluated the effective mean lateral fraction k from measured area frequency functions, in six radial zones, of 4227 Sacramento Peak flares (H. J. Smith, Solar Res. Note No. 3). These frequency functions f_i (A) were first smoothed by converting to integral functions

$$N_i (A) = \int_A^{\infty} f_i(a) da,$$

and then normalized to constant area of included flare-yielding latitude zones. The constant k was determined by comparing plots of log $N_i(A)$ vs.

log A, and noting the displacement $\Delta \log A = \log m_{i,j} = \log (C(\phi_i)/C(\phi_j))$, which produces agreement for any point or part of the curves. From this k can be computed by

$$k = \frac{\cos \phi_i - m_{ij} \cdot \cos \phi_i}{m_{i,j} \sin \phi_j - \sin \phi_i} .$$

In this way, k was found to have the value 0.16 with a variance of 0.06, for the average of middle values of area for this sample. However, these data indicated that k depends strongly on A. This latter fact could indeed have been predicated from the known shapes of flares at the limb; small flares frequently exhibit heights comparable to their basal diameters, but the largest seldom reach heights exceeding .05 solar radii. (Flare surges and sprays often reach greater heights, but since they are normally treated as phenomena separate from the generating flare, they are excluded from this discussion.)

Thus the correction formula (2) is a crude approximation for two reasons: (a) The larger flares frequently occur as several disconnected fragments, or as decidedly concave shapes. Consequently the formula tends to overestimate their plan areas. (b) The ratio A_l/A_p is not constant, but decreases with increasing area, and undoubtedly has considerable dispersion. Hence small flares will be overestimated; and since these are far more numerous than larger ones, the mean importance of corrected limb flares can be expected to be larger than at the center of the disk.

3. Sacramento Peak Flares

Until recently, Sacramento Peak and some other western hemisphere observers have reported flare importances based on measured areas. About a year ago some of the users of these reports expressed considerable regrets at the systematically smaller importances assigned to flares near the limb, as compared to the mean of most other observatories' description of the same flare. This is significant, for some users rely very heavily on the complete, immediate reports provided by Sacramento Peak and other Western American observatories which follow the same practise. Moreover, the measured areas as well as the systematically smaller importance reported by these observatories were being published without qualification in the Quarterly Bulletins. This is one of the causes of the notable inhomogeneities in the International flare data, discussed by Dodson and Hedeman (1960 J. Geoph. Res. 65, 123). Initially, in order to correct this situation, it was proposed that we continue to report only measured areas, but to base importance classifications on areas corrected by the secant law (1). However, there was strong resistance to this scheme because of the well known objections to it discussed in the previous section. After considerable exchange of opinion between interested individuals, it was agreed that Hawaii, Lockheed, Climax and Sacramento Peak would adopt C. Warwick's proposed use of formula (2) for correcting flare areas in assigning importance classifications (Memoranda of R. G. Athay, 15 Sept. and 29 Nov. 1960). The new procedure became effective 1 October 1960. At Sacramento Peak, areas continue to be measured as before (H. J. Smith 1959). Corrections are applied to the measured areas of flares by tabular reference (Table 4), before assigning importances according to Table 1. In Figure 2 C_W can be compared with C_B and the secant law. (Elegant graphs have been devised for this purpose at NBS and Lockheed.)

We note in passing that one case of a large flare at the limb (5 December 1960) caused consternation when the corrected area was found to be just under 7000 millionths! In this unique case, the major flare area lay within the limb, but a part (later considered separately as a spray prominence) projected over the limb. The SPO observers assigned a mean position of R. V. = 1.00, and used an area correction factor 5.0. After careful re-examination of the film by 5 observers, it was decided to rectify the area by the secant law (1), using optical projection on a globe. We have applied this procedure to three other large flares near the limb, and consider it the preferred correction technique for rare events of this kind. (The method and results will be discussed elsewhere.)

Table 4 reveals a geometrical peculiarity of the correction formula (2). In the range of radius vectors from 0.01 to 0.38, $C_W(\phi)$ 1; for R. V. = 0.17 to 0.22 it has a minimum value of 0.98. The meaning is simple: at small heliocentric distances the lateral area contributes more to the projected area than is lost by foreshortening of the plan area. The amplitude of this effect, and the range of ϕ over which $C(\phi)$ is less than unity, are a function of the lateral fraction k. Such a reduction in the incidence of flares near the center of the disk seems to be required by the visibility function of small areas, as indicated by Figure 1. At first sight this minute decremental correction appears trivial. However, it actually has some statistical significance, since it applies to a considerable fraction of the number of flares observed, by virtue of the visibility function.

While the correction (2) seemed at the time of adoption to be a reasonable compromise between the secant law and no correction at all, it appears highly desirable to know more of its statistical effect on a large, homogeneous sample of flares. The Sacramento Peak data are admirably suited to this purpose, since they are numerous, homogeneous, and comprise a fairly complete sample down to the smallest areas. To this end we have used a digital computer to apply the correction (2) to the complete body of data derived from the half-Angstrom flare patrol, up to 1 October 1960, and to analyze the effect of this correction.

4. Data Manipulation

All the statistical data discussed in this report were computed by a Bendix G-15, provided by Contract AF 19(604)-6664 with the High Altitude Observatory. This is a serial, binary, drum memory machine with typewriter and hexadecimal paper tape input and output. We used it in an interpretive decimal floating point mode (INTERCOM), which provided only 11 channels of 100 words for data and program storage. These facilities dictated a data format of 7 words per flare, and 14 flares per channel. For each flare, the paper tape contained the following information:

1. SPO flare number
2. Measured area
3. Old importance
4. Geocentric position angle
5. Radius vector
6. (Uniformly corrected area)
7. (New importance)

A special hexadecimal tape preparation program was written to permit type-in of items 1 to 5, and punch-out entries each successive 14 flares. This same program simultaneously computed uniformly corrected areas according to formula (2), and assigned new importances according to Table 1. Items 2 and 3 are not redundant, as they may at first sight appear to be; the serial numbers contained some gaps and duplications, due to errors in film analysis, and are not always in chronological order, while the old importance classifications do not exactly follow the area limits of Table 1, and contain the essentially photometric subclasses 1+, 2+.

The 7482 flares (SPO numbers 2764 to 10267, observed between 1 July 1957 and 4 October 1960) thus occupied 540 blocks of paper tape, 4400' in length, distributed in 22 magazines of 25 blocks each. After preparation each tape was listed, proof read, and corrected. We found to our dismay that paper tape is not a reliable data medium, at least as we used it. After several trials, losing hours of computation, we were forced to make manual checks of each data block as it was read in, thus relinquishing much of the advantage of automatic computation. Despite these precautions, occasional errors persisted, so that totals of the area and importance frequency functions do not agree exactly. We endeavored to detect and correct these errors, but a few residual discrepancies persist. These are statistically insignificant, as far as our results are concerned, and probably fewer than would have resulted from strictly manual methods. (INTERCOM carries slightly more than 5 significant decimal digits, so that rounding and truncation errors are negligible.)

Two useful byproducts have been obtained from the paper tapes: (a) A list of the 1003 flares whose importance was revised by the uniform area correction, including date, times of start, maximum and end, geocentric coordinates on the disk, and old and new areas and importances. This list will be issued as SPO Solar Research Note No. 12, 20 May 1961. (b) A complete listing of the paper tapes including only the data enumerated above. Copies of this are available on request.

The disappointing experience of reliability of paper tapes, and the sheer bulk limitation imposed by this medium, led us to consider 80 column Hollerith cards for future work. The paper tapes were transcribed to punched cards by the maximum G-15 installation at the Southwest Regional Office of the Bendix Computer Division. We are grateful to Mr. Richard Walz and his colleagues for this considerable favor. Anticipating the future use of the Univac 1103A computer at Holloman Air Force Base, we elected a UNICODE format (the Remington-Rand Fortran algebraic compiler) which admits clear language coding and a maximum density of information recording. The data of a single flare are recorded on each card as follows:

Col. 1-5	SPO flare number
7-12	Date (month-day-year)
14-18	Starting time
20-24	Maximum
26-30	Ending time
38-40	Geocentric position angle
42-44	Radius Vector
55-58	Measured area
60-62	Old importance (0.5, 1, 1.5, etc., being 1-, 1, 1+, etc.)
64-65	Intensity
71-72	Relative area

(Other columns are blanks; UNICODE requires 1 or more blanks to separate data words, and that columns 73-80 be blank.)

The coding C in columns 14, 20 and 26 has the following meanings:

0	No comment
1	$<$ (before, or E)
2	$>$ (after, or D)
3	Uncertain: $\lesssim$, $\gtrsim$, ~ , : , u

It is unfortunate that no uniform card format has been established; those in use at the CRPL, NBS and the Lockheed Solar Observatory do not admit all the data reported for Sacramento Peak flares, or include data not reported for them. However, card translation is a trivial problem for modern computers, and the existing card copy can readily be transcribed to other formats for special purposes. When the first generation card deck was received from the Bendix Corporation, with only the paper tape entries punched, we added the date, the times of start, maximum and end, the visually estimated arbitrary intensity, and the relative area. At the time of writing, this second generation card deck is complete and proof read. With this material we hope to extend our study in the near future. The first phase will require the computation for each flare of its heliographic latitude and longitude from the central meridian, using exact formulae. This will serve to check the analogue coordinate conversions carried out in the daily reductions, and will provide the means of studying the latitude distribution of flares, center-limb variations of flare incidence in a natural uniform, coordinate system, and association of subflares and flares with individual active regions. Other questions inviting inquiry are the frequency distributions of flare durations, intervals between flares in individual active centers, and their relationship to area and intensity. In addition, we hope to maintain the card deck concurrently, and to use it to provide copies of the Sacramento Peak flare report to our users.

5. Area and Importance Frequency Distributions by Uniform Correction

For reasons to be discussed in the next section, we shall refer to $C_W(\phi)$, equation (2), as the uniform correction, since the rectification factor is independent of area. (In this sense the secant law (1) and Ballario's empirical correction $C_B(\phi)$ are also uniform.) The fundamental results of our counts are the area frequency functions, Tables 6 and 7. Parts a of these tables report the actual flare counts, while parts b and c give the percentage population in each cell for corrected areas ≥ 100 and < 100 respectively.

The crucial test of any projection correction system is that it renders the area-frequency function invariant with position on the solar disk (HJS 1959). Since the correction is a function of radius vector, Tables 6 and 7 are included to show clearly the dependence of changes in the distribution functions on radius vector. The number of zones was kept to 5 (plus the limb) in order to reduce the statistical uncertainty of too small data samples. An effort was made to keep these zones equal in area, in order to homogenize the statististical uncertainties. (Table 11 shows the relative zonal area for various divisions of the solar disk and hemisphere, computed from

$$S(r_1, r_2) = \int_{r_1}^{r_2} \frac{dr}{(1 - r^2)^{1/2}}$$

Near the limb, dS/dr is large, and division at exactly equal fractions of the hemisphere does not always occur at convenient values of the radius.) However zones of equal area of the hemisphere would not themselves yield invariant flare distributions, even with a perfect rectification, for two reasons:

a. Flares occur within the belts of latitude ranging roughly from 5 to 40 degrees from the equator, at a modal latitude which varies with the phase of the solar cycle (Waldmeier 1959, Zs. f. Ap. 47, 81). An equal-area geocentric zonal division samples varying parts of these zones. Hence, the counts in a zone between radii R_1 and R_2 should be normalized by the factor

$$N(R_1, R_2) = 4\int_{R_1}^{R_2} p(\arcsin y)\left[\arcsin\sqrt{\frac{R_2^2 - y^2}{1 - y^2}} - \arcsin\sqrt{\frac{R_1^2 - y^2}{1 - y^2}}\right]dy, \quad (A)$$

where p (b) db is the probability of flare incidence between latitudes b and b+db, and y = sin b. Since the G-15 tapes did not include heliographic coordinates of flares, it is not yet possible to obtain p (b) for the complete flare sample. However sample counts were made for part of the sample (cf. § 6), which permit us to compute the normalizing factor N.

b. The foreshortening effectively eliminates small flares in the limb zones, as is demonstrated by Figure 1. Thus, even a division of the disk into uniform flare producing zones (i.e., lunes of equal longitude interval) would still not show an invariant frequency distribution of correctly rectified areas. If a discrete detection threshold were indeed realized, then an invariant distribution function would exhibit merely truncation at a progressively larger lower limit of area, as the zone is chosen further from the meridian. The finite width of a zone tends to wash out the truncation area over a small range. Moreover, seeing and image contrast as well as a certain randomness of the observer's judgement of what is a flare worthy of recording, will tend to increase the diffusion of the threshold area.

Tables 6c and 7c and Figures 3 and 4 reveal this second effect very clearly. The frequency distributions of measured areas become much more skew with increasing foreshortening. When the uniform correction is applied, the modal area increases from roughly 25 millionths in the center to about 55 millionths in the limb zone. The principal effect of a correction procedure is to deplete the smaller area ranges, while increasing the population of larger areas. Because small flares are lost through foreshortening, the correction cannot restore the area-frequency function in the limb zone to that observed at the center. This observation points out the chief defect of most other studies of the foreshortening effect: The true frequency distribution of observable flares at the limb will not be identical to that at the center.

Attempts to compensate for the loss of intrinsically small flares will result in gross over correction. Moreover, an empirical analysis of area foreshortening must be based on a data sample which is complete down to the limit of detectable areas. If one uses a sample truncated, say, at 100 millionths observed area, a large fraction of the importance 1 flares near the limb will be omitted.

One last remark is pertinent to the question of determining a foreshortening correction from the frequency distribution of measured areas: data pertaining to the limb, $R > 0.99$ ($\phi > 84$ degrees) are useless for such analysis, and should be excluded. The reason is simply that at the limb one does not see the entire lateral area of a certain fraction of flares. Many limb flares are at last partially occulted by the chromosphere at $\phi = 90$ degrees, and as a consequence their area distribution is meaningless.

To return to our discussion of the uniform correction, it is clear from the preceeding remarks that we must judge its success by inquiring whether the area frequency function remains invariant at all heliocentric distances, while recognizing at the same time that observational selection will deplete small areas from the rectified distribution near the limb. The most satisfactory way to make such a comparison is by the integral functions, which we defer to section 7. In the interests of historical development we shall here merely note the effect upon the distribution of rectified flares in importance classes. These distributions are given in Tables 9 and 10, both as numbers and percentages. The observed relative frequency of importance 1-, 1, 2 and 3 flares at the center of the disk is probably the true frequency, since foreshortening is almost negligible when $\phi < 50$ degrees. The percentage population outside the central zone have not been normalized to a constant flare incidence per unit area; they do not recognize the loss of small flares near the limb, and are tabulated mainly to demonstrate this effect. Rather, the significant information in these two tables is to be found in the ratios of numbers of importance 2 and 3 flares to the number of importance 1 flares. It is reasonable to assume that no importance 1 flares are lost in the region $R < 0.6$. The maximum foreshortening factor is probably less than 2.5 within this zone; thus the projected area of a minimum importance 1 flare would be > 40 millionths, which is above the threshold of detection. In this way we find that the true ratios of numbers of importance 2 and 3 to importance 1 flares are .204 and .034 to one. These ratios are reproduced quite well by the uniform correction up to $R = 0.9$ ($\phi = 83.6$ degrees) as shown by the following tabulation:

Zone	Imp. 2/Imp. 1	Imp. 3/Imp. 1
0-.59	.204	.034
.6-.79	.203	.035
.8-.9	.186	.033
.91-.97	.158	.022
.98-.99	.237	.062
> .99	.420	.119

At greater central distances, the uniform correction does not rectify [illegible] accurately; for R = 0.91 to 0.97, the correction is too small, and just inside the limb (R = 0.98 to 0.99) it is too large. Equation (2) exaggerates the importance of small limb flares. This is not a severe criticism of the uniform correction, of course. The conclusions pertain to small numbers with large statistical uncertainty. However, an erroneous trend is certainly manifested, leading to the hope that some small improvement might profitably be sought. An experiment to this end is described in the following section.

Before leaving the uniform correction, it is worthwhile to study further its effects on importance characteristics. Using the G-15 output of reclassified flares (Solar Research Note No. 12), we have collated the revised SPO flare list with the IGY quarterly Bulletin (IGY) and the CRPL F-Series Part B (1959-1960). For those flares whose importance was changed, we noted: (a) flares of importance 1 or greater not reported by any other observatories --- 635 cases; (b) flares of importance 1 or greater reported by other observatories and confirmed by the reclassification --- 368 (c) SPO flares in these tabulations, whose importance was upgraded --- 144 cases. In all, one thousand flares were upgraded in importance, 15 per cent of the sample. This observation emphasizes the severity of the error of making no foreshortening correction especially in view of the quite large number of flares observed only at Sacramento Peak.

Flare durations are loosely correlated with area. Now, reclassification removes from a given importance class those flares of larger true areas displaced into that class by foreshortening. Hence we expect that the mean durations by importance will be decreased by reclassification. That is exactly what happens, as the data below show:

Flare Durations (Minutes) by Importance Class

		Importance			
		1-	1	2	3
	Old Class	16.8	36.5	61.7	-
Mean:	New	16.5	27.8	48.2	36
	Old Class	10	26	42.5	-
Mode:	New	10	16	20	27.5
	Old Class	13	29	55	-
Median:	New	13	21	37.5	27.5
Q. B. 1935 -1954 (mean)		-	21.5	40.2	74

The effect on lifetimes of subflares is small, since the fractional change in their population amounted to only 13 per cent, of which three quarters were importance 1 (with correspondingly shorter durations). Reclassification helps to reduce the discord between mean durations of SPO and those reported in the IAU Quarterly Bulletins, but the former are still systematically longer for smaller flares. This is puzzling, since we know that subflares at the limb are overemphasized; the discrepancy ought to be in the other sense, since subflares are shorterlived on the average. The data for importance 3 flares are inadequate for comparison: too few importance 3 flares were completely observed for the data of old classifications to be significant, while the 18 flares transferred to importance 3 probably contain a few that are overemphasized.

6. A Graduated Correction

In describing the uniform correction, we noted that it was based on several contrary to fact hypotheses - chiefly that the average ratio A_l/A_p is independent of A_p, and that a flare is a simply connected convex domain of uniform height. The observed effect of overemphasizing small limb flares thus suggested that we experiment with a modified foreshortening correction of the type (2), in which the lateral area weighting factor 0.2 is replaced by a function of area. Initially we assumed that a hemispherical shape characterized subflares ($A_l/A_p = 0.5$), while larger flares had the proportions derived statistically. More mature reflection, and a careful examination of the shapes of more than a hundred limb flares, indicated the naivete of this concept. Many flares are actually taller than they are broad at the base; others exhibit irregular projections into the corona, and look like weired mushrooms; and finally, loop structure are common, particularly in the post maximum phases. For such odd flares, A_l/A_p is probably greater than unity. Unfortunately observed limb flares offer no means of studying the statistical distribution of the ratio. Even though our sample included 500 flares reported at $R \gg 1.00$, it includes far too few intrinsically large flares, and many individual cases are obscured by occultation of the flare by itself and by the chromosphere. Finally, many flares violate the requirement of convexity and simple connectivity.

Consequently, we made the choice of studying the effect of a strictly arbitrary graduated correction:

$$Ac = \frac{A_m}{k.\ R + (1 - R^2)^{1/2}} \qquad k = \begin{cases} 0.5 & A_m < 100 \\ (0.7 - A_m/500) & 100 \leq A_m < 250 \\ 0.2 & A_m \geq 250 \end{cases} \qquad (3)$$

This correction is that suggested above: the apparently smallest flares are assumed to have $A_l/A_p = 0.5$ (hemispherical shape), the largest to have the shape inferred by C.S. Warwick ($A_l/A_p = 0.2$), and the intermediate flares to lie between these extremes. Figure 2 (dash line) illustrates the projection coefficients for the small flares ($k = 0.5$), and Table 5 gives the numerical values. At $R = 0.25$ ($\phi = 23.5$ degrees), the function diminishes the apparent area by 6 per cent. The maximum correction, at the limb, amounts of course to $1/k = 2.0$ for subflares and 5.0 for flares with $A_m > 250$. The G-15 was used to reclassify flares with $A_m \leq 250$ by this graduated correction; only the corrected area frequency function was recorded. This is reproduced in Tables 8, in the same form as the distribution of measured and uniformly corrected areas, and in Figures 3 and 4. Critical examination of the results by integral functions are again deferred to section 7. Meanwhile, let us look at the distribution in importance classes; taking the ratio of numbers of importance 1 to importance 2 and 3 flares (Table 9c):

Zone	Imp 1/Imp 2	Imp 1/Imp 3
0-.59	.276	.039[5]
.6-.79	.317	.034[5]
.8-.9	.431	.069[5]
.91-.97	.122	.011
.98-.99	.118	.137
>.99	.189	.094

Comparing these data with the standard ratios .204 : 1 and .034 : 1 (A_m in $R \leq 0.59$), we see that the experimental graduated correction was singularly unsuccessful. Only at the limb is the proportion of importance 1, 2 and 3 flares improved over that yielded by the uniform correction. In the inner zones, $R \leq 0.90$, the relative frequencies are actually worse than that given by the measured areas. This is clearly the fault of undercorrecting (actually diminishing) the small apparent areas: flares which should be importance 1 are falsely degraded to subflare status.

Only one useful result comes from the experiment, and even that is uncertain. It appears that at the limb, the maximum value $C(90°) = 5.0$ is too large as a uniform correction, and that the graduated correction (3) seems to give more consistent statistical results. However this conclusion is doubtful, for the reason stated earlier. Translimb flares, whose lateral area is truncated by limb occultation, are added to the observed area frequency distribution as smaller flares. The effect of occultation by the flare it self (in the case of multiply connected and semi-concave shapes) will partly compensate this statistical effect but to an unknown degree. For that reason it does not appear desirable to estimate from the height-frequency distribution the contribution of translimb flares to the limb zone sample.

7. Areal Integral Functions

A more objective and satisfactory way to judge the success of area corrections is that devised by C. S. Warwick. Define N(A) as the number of flares in a zone with areas equal to or greater than A. The integral function N (A) must be normalized to areas of equal probability of flare production, according to (A). Then plots of log $N(A)_m$ v. A_m for successive zones will reveal: (a) the loss of small flares near the limb, by a turning down of the limb zone curves compared to the central zone curve; (b) the effective foreshortening in each zone as a displacement of the respective curve to the left of that for the central zone. An areal dependence of the foreshortening should be revealed by these displacements. This method was indeed how C. S. Warwick determined the mean ratio A_l/A_p = 0.2. Conversely, the integral functions of perfectly corrected areas should all coincide with that of the measured areas in the central zone.

In order to apply this method, we needed the latitude frequency distribution function of flares p (b), and values of the integral (A) for the zonal divisions considered here. Since the G-15 did not provide statistics of the heliographic distribution of flares, counts by hand were made instead in the observer's reduction sheets, for 1957 July - December (1320 flares) and 1960 January - December (1507 flares). These observed latitude distributions are reported in Table 12 and shown in Figure 5. The migration of the flare latitude zones is reflected in the mean latitudes ($\overline{b}$ = 19.7 in 1957b and 15.6 degrees in 1960), as well as in the distribution functions. For our analysis of flare area statistics, the averaging is desirable; however the dispersion of latitude is so great that the difference between the two sample periods is insignificant.

We reproduce in Table 13 the integrands of the normalizing function (A) for the zonal divisions of interest; and in Table 14 the weighted normalizing factors themselves. Using the data in Tables 6a, 7a and 8a to construct integral functions, and the normalizing factor in Table 14 to adjust these zone by zone to the same expectation as the central zone, we obtained the data plotted in Figures 6, 7, 8. For the record, the rectified integral functions are also listed in Tables 15. We excluded from this analysis all flares reported as R = 1.00, for as noted in the preceding section, they are irrelevant to the question we now deal with.

In examining the curves in Figures 6 - 8 we note a peculiarity of the integral functions. Statistical variation in the population of successive area cells of the frequency distribution produces vertical and horizontal steps in the integral functions. The limb zones, with the smallest populations, show these fluctuations most vividly, particularly in the range of large areas. The solid line in each figure, representing the central zone, presumably portrays the true integral function.

Figure 6, the measured areas, shows the rectified integral functions of outer zones displaced downwards by different amounts for each zone. C. S. Warwick's determination of $A_l/A_p = 0.2$ was derived from measurement of these displacements. If the uniform correction were exactly valid, then the integral functions of uniformly corrected areas (Figure 7) should all overlap. We anticipate fluctuations on the left, where the statistical uncertainty is greatest. Moreover, the rectification should not restore the missing flares of small area; hence the curves of the outer zone should fall below that of the central zone in the domain of small corrected areas. The chief fault of the uniform correction is the gross overcorrection of all flares in the zone R = 0.98 to 0.99. Apart from this, the average results of this method should be considered satisfactory. Figure 8 speaks for itself: The experimental graduated correction (3) undercorrects the small flares in all zones. The curves for the two outer zones (x's and o's) more or less overlap for $Ac < 100$; this implies that the correction in the outer zone is too large. (The same effect is manifest in Figure 7 also). However, this excess of small flares may also be the result of limb darkening, which favors the discovery of intrinsically smaller flares. We entertained no great expectations for this graduated correction, and it clearly is inferior to the method of uniform correction by equation (2).

With the integral function of measured areas, it is possible to recompute A_l/A_p by the method of section 2. Our sample is nearly twice as large as the one C. S. Warwick used, and the results might possibly be improved. We have done this, comparing each zone directly with the central zone. (The original determination of k was by comparing all zones together in pairs, in order to average out statistical fluctuations.) Our results, shown in Figure 9, reveal a very clear dependence of k on the mean radius vector of the zone, as well as its anticipated dependence on A_m for $R \geqslant 0.8$. The values of k in the outermost zone, R = 0.98 to 0.99, are of the order 0.3 to 0.4, which confirms our interpretation of Figure 7. The abrupt decrease of k for the smallest flares in all zones reveals nicely the effect of loss of small flares. The indicated values of k in this domain should not be used for foreshortening correction, of course for this practise would greatly overestimate the importance of observed flares. The point of inflection of the k-curves should in principle shift to progressively smaller areas with increasing radius vector. The fact that it does in the range 0.6 to 0.98, then reverses near the limb, is probably due to the effect of limb darkening mentioned earlier. The dependence of k on R must be attributed in part to this phenomenon, and in part to the effect of self occultation. The small scale sinuosity of the curves results from statistical fluctuations; k is very sensitive to small charges in the measured parameter log m. In view of the summary conclusions we shall state in the following section, we merely say now that though Figure 8 presents the basis of a more accurate foreshortening procedure, we did not pursue the problem further.

Before leaving the integral functions, it is of interest to consider what information they give on the subject of flare shapes. A true hemisphere would of course indicate $k = A_l/A_p = 0.5$. The model adopted by C.S. Warwick, a convex plan area with vertical sides, can be approximated by a cylinder of diameter d and height h, giving $k = \frac{4h}{\pi}/d$. Thus for $k = 0.2$ or 0.5, $h/d = 1/6.3$ and $1/2.5$ respectively. A less restrictive simple shape is the cone, with sloping sides, where $k = {}^{2h}/_{\pi d}$; this configuration gives $k = 0.2$ and 0.5 when $h/d = 1/3.2$ or $1/1.28$. The conical shapes actually observed in limb flares very rarely are so obtuse; h/d ranges between 1/1 and 3/1 in the great majority of conical flares. Moreover, the projection law of a cone is quite different from that of a cylinder. When $A_l > A_p$ (i.e., $h > \pi d/2$), the gradient of the foreshortening near the limb is very small; indeed this is generally true for any simple shape, since the derivative of the sine function is small and of the consine large, near $\phi = 90$ degrees. Systematic inclination of radially exterded flares would produce a distortion of their apparent foreshortening, as Ballario has shown ("The Height of Solar Flares in H-α Radiation," Osservatorio de Arcetri, 25 May 1961); but the evidence for an implied east-west asymmetry in flare incidence is essentially negative (Solar Research Note No. 3). Obviously tall, thin flare shapes are rare, since the empirical values of k all lie between 0.12 and 0.39. However, their existence may well contribute to the observed overcorrection by the uniform function (2).

8. Conclusion

The object of this report was to study the effect of the uniform correction (2) upon the area-frequency distribution of 7500 homogeneously observed flares. As we have seen in the preceding section, the results are satisfactory except in the extreme limb. The data resulting from this analysis provide the means of generating a more precise correction, but it does not appear desirable to pursue this much further. The simple geometrical model is only a rough approximation to the real shape of flares, and further refinement of the foreshortening correction would require more elaborate models. The data on limb flares are moreover not adequate for a sound statistical investigation of the relative frequency of the various shapes and proportions of the vertical cross sections. We have seen that the conical flares occurring in the extreme limb zone R = 0.98 to 1.00 are overcorrected by the function (2), and have suggested that their frequency is increased by limb darkening, or at least the proportion of small flares is increased by their geometrical properties. A better analysis of these phenomena is possible, but the intrinsic interest and cosmical significance of foreshortening and flare shapes probably do not merit much further work. In the interests of adequate importance classification, the following proposals are offered:

a. The uniform correction (2) should be used for all flares with their center of gravity at $R < 0.98$, both to determine importance and to yield a corrected area.

b. Only a measured area and a subjective importance assignment should be given for flares at $R = 1.00$. This is especially necessary when the chromosphere can be seen in projection on the flare; but even if a small part of the flare area lies within the limb, an observer's judgment of importance is certainly superior to an undiscriminating one-parameter correction formula.

c. In the limb zone, $R = 0.98$ to 0.99, the correction factor 2.50 should be used and a corrected area reported, unless, in the observer's judgment from the appearance of the flare, a large fraction of the projected area is lateral area. Then he will report a subjective importance and only the measured area.

The uniform correction, modified by these compromises, will yield statistically sound data on flare importances and area distributions. By relaxing the rigidity of a strictly formal correction, obviously small flares need not be overcorrected at the limb. Conversely, a uniformly corrected translimb flare might underestimate its importance; the proposed flexibility would, for example, allow an observer to call importance 3 a flare consisting only of a few bright beads distributed along 10 degrees of the limb. Of course only a small per cent of the total reported flares are thus affected.

To these we would like to add one more proposal:

d. Limb flares should be omitted in any discussion of flare incidence and area distribution. Their true plan areas not accessible, and a considerable fraction of the numbers of small events are not observed. We can adequately study these properties from the center of the disk sample, and any statistical inference of the true from the observed numbers near the limb will be uncertain. A complete discussion of limb flare statistics is certainly possible, but of dubious value. After all, the knowledge we might thus gain about the shapes of flares is really rather trivial, particularly in view of the information yielded by direct observation of limb flares.

To implement this last proposal, we have computed the global distribution of flare importance incidence. These numbers are the uniformly corrected areas in the zones $R < 0.8$; 84.6% of reported events are subflares; of the balance, the distribution among importances 1, 2 and 3 are 78.6%, 19.2% and 2.2%. The same distribution over the visible hemisphere will be different, because of observational selection. Note that the zone $R < 0.8$ includes 59.1% of the hemisphere, and contains 62.9% of all the flares reported. When we take only the flares with $Ac \geqslant 100$ millionths, the zone includes 42.8% of those reported; this discrepancy points out the loss of importance 1 flares by foreshortening.

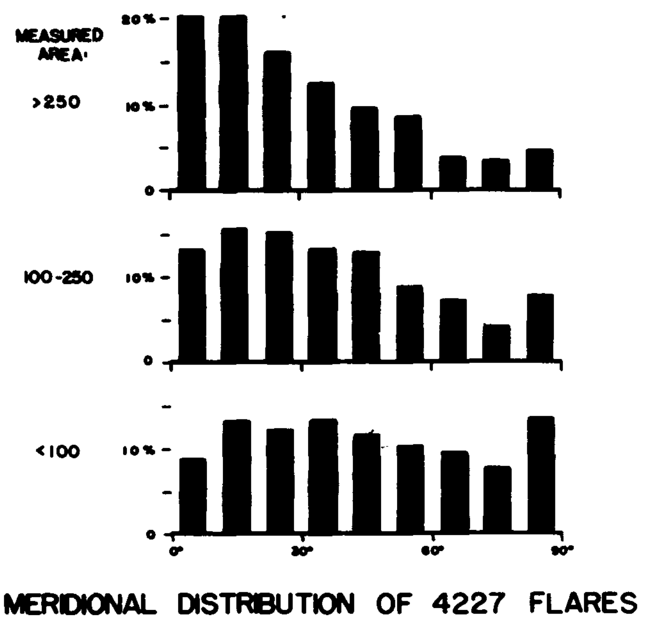

FIG. 1. Longitude distribution of flare incidence, as function of measured areas. The zone 80-90 degrees includes limb flares $\phi \geq 90$ degrees. (From H. J. Smith, 1959)

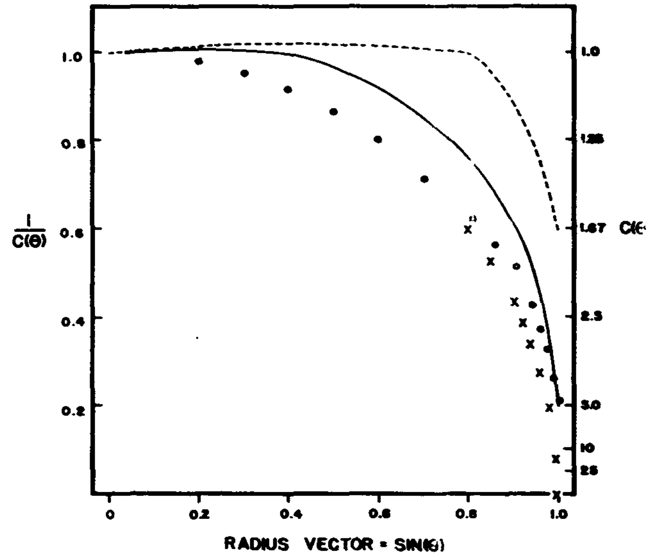

FIG. 2. Area projection coefficients. [Circles: $C_B(\phi)$, Table 2]; [crosses: secant law, Eq. (2)]; [dashed line: graduated correction for $A_m < 100$, Eq. (3)].

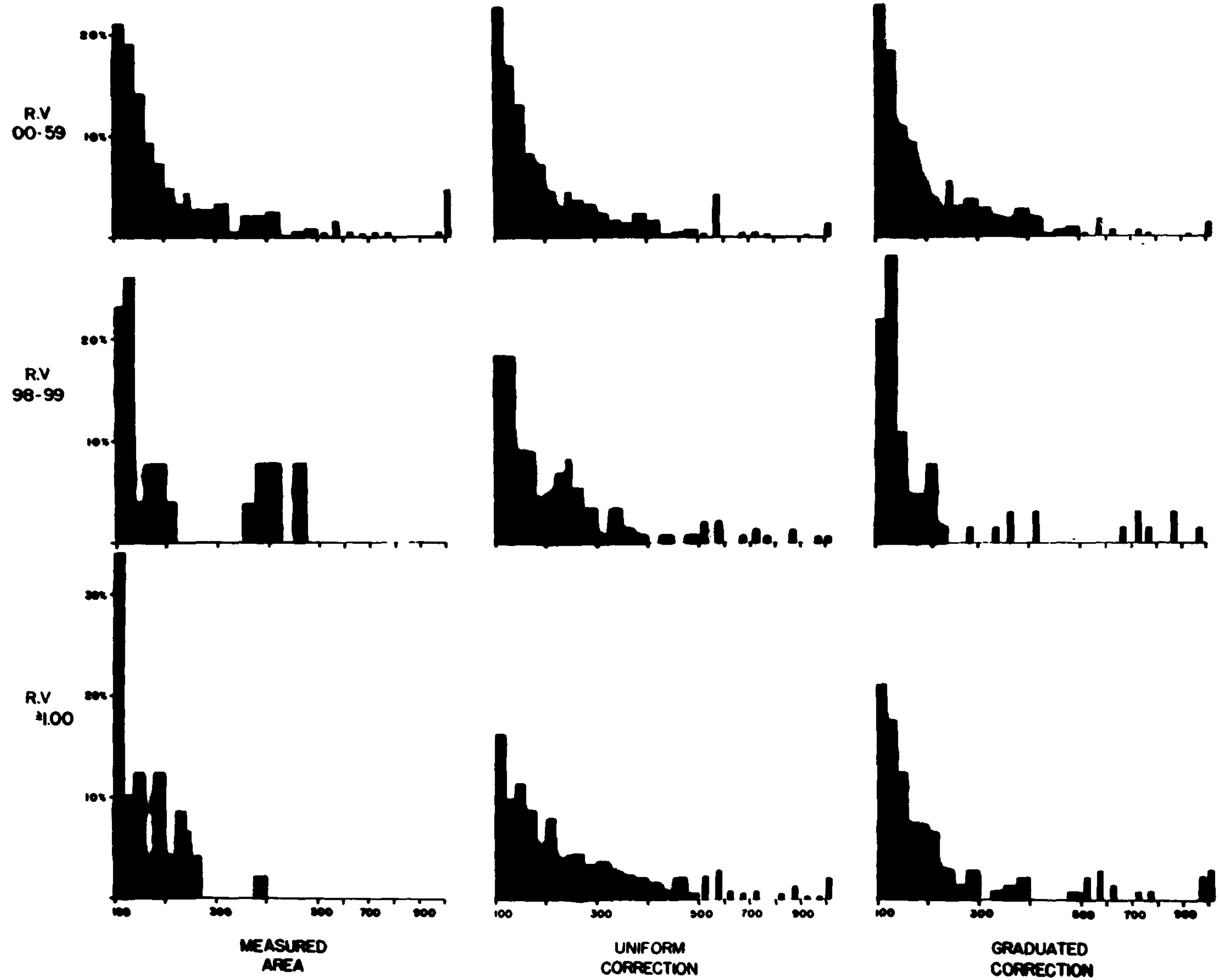

FIG. 3. Frequency distribution of measured and corrected areas, $A_m \geq 100$.

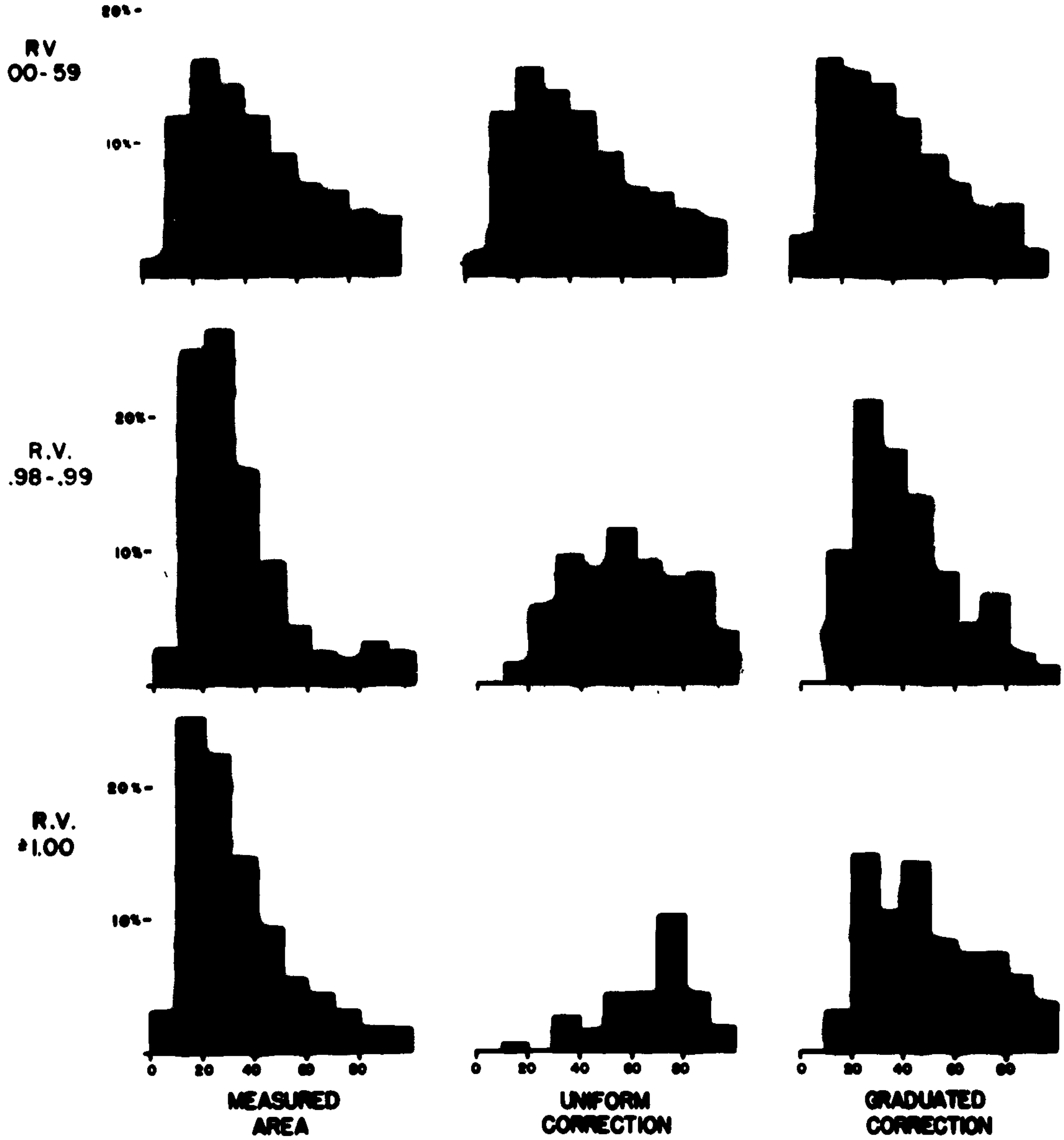

FIG. 4. Frequency distribution of measured and corrected areas, $A_m < 100$.

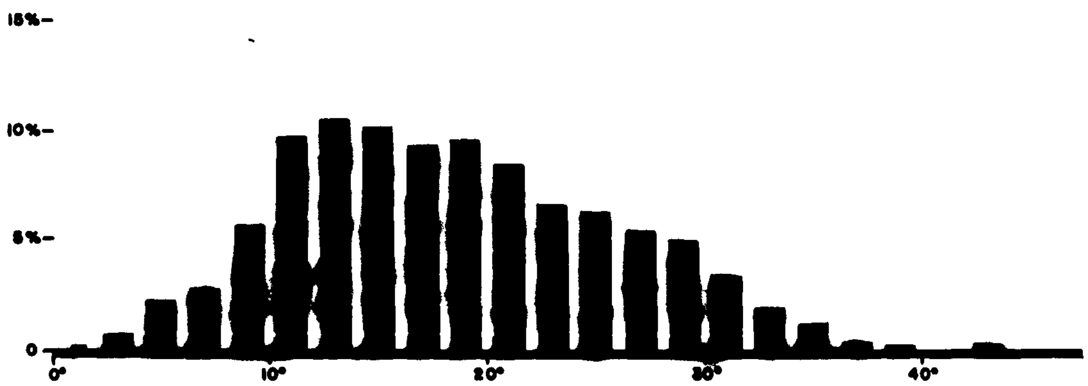

FIG. 5. Distribution of flares in heliographic latitude.

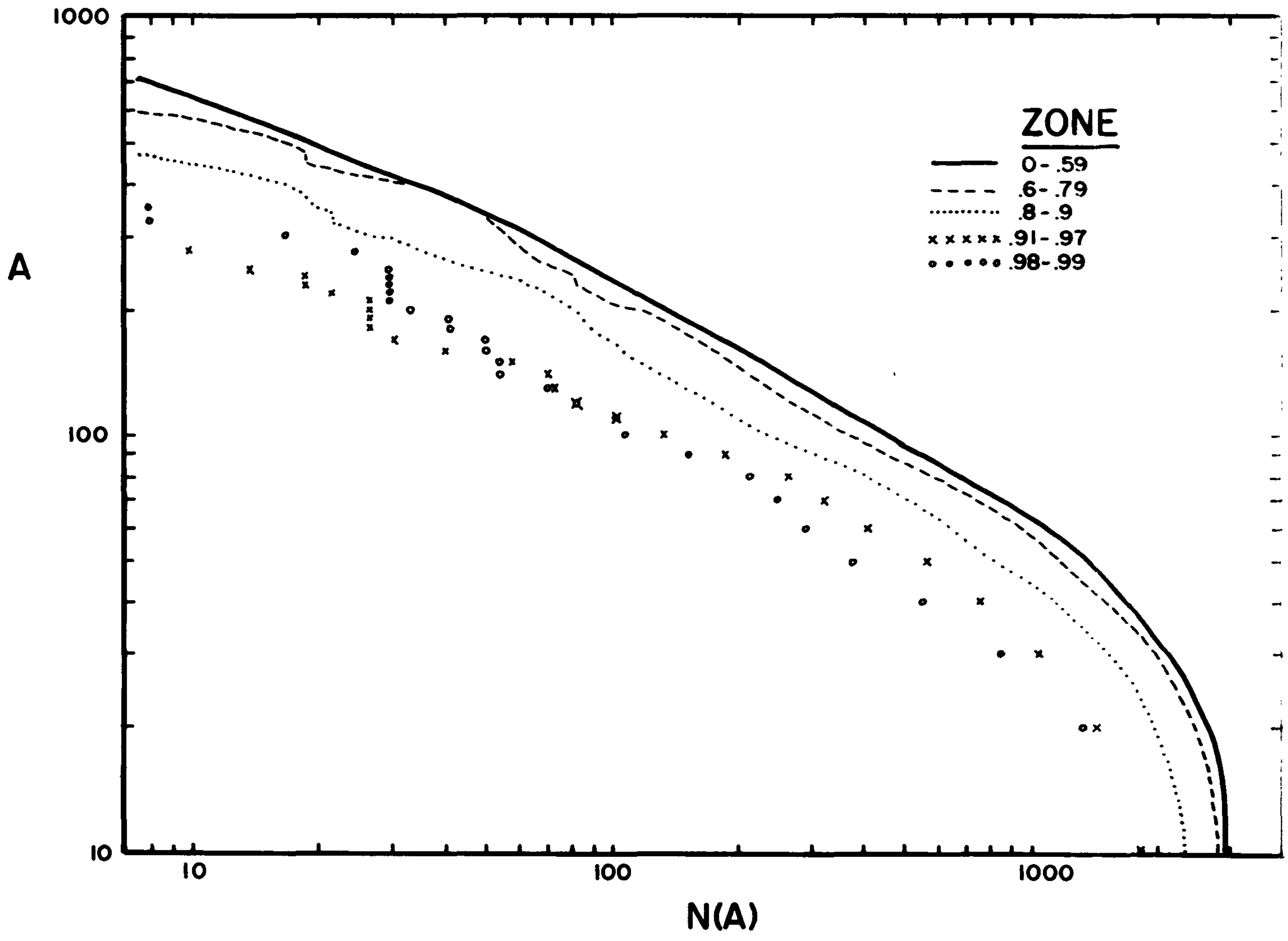

FIG. 6. Integral functions of measured areas.

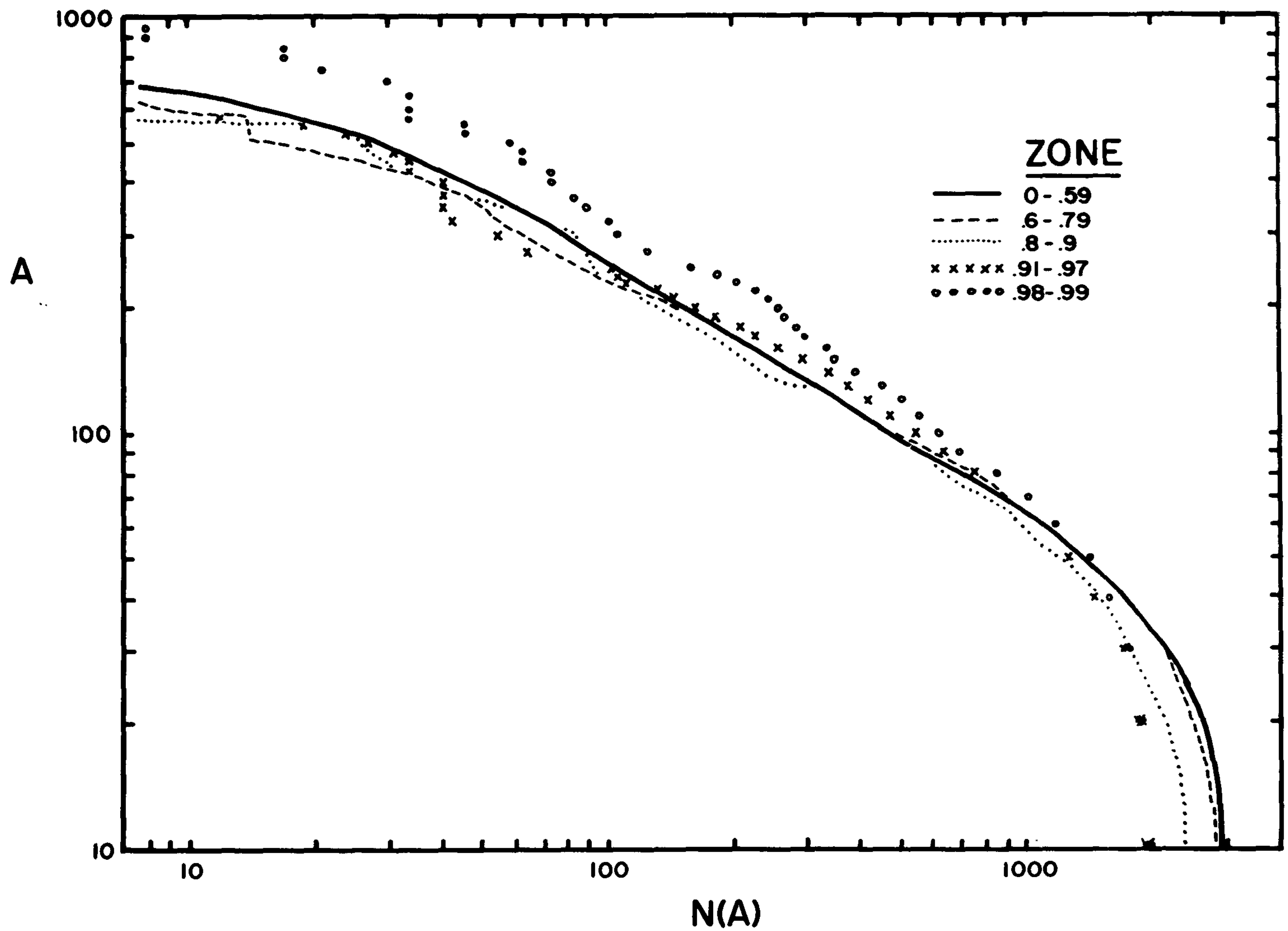

FIG. 7. Integral functions of uniformly corrected areas.

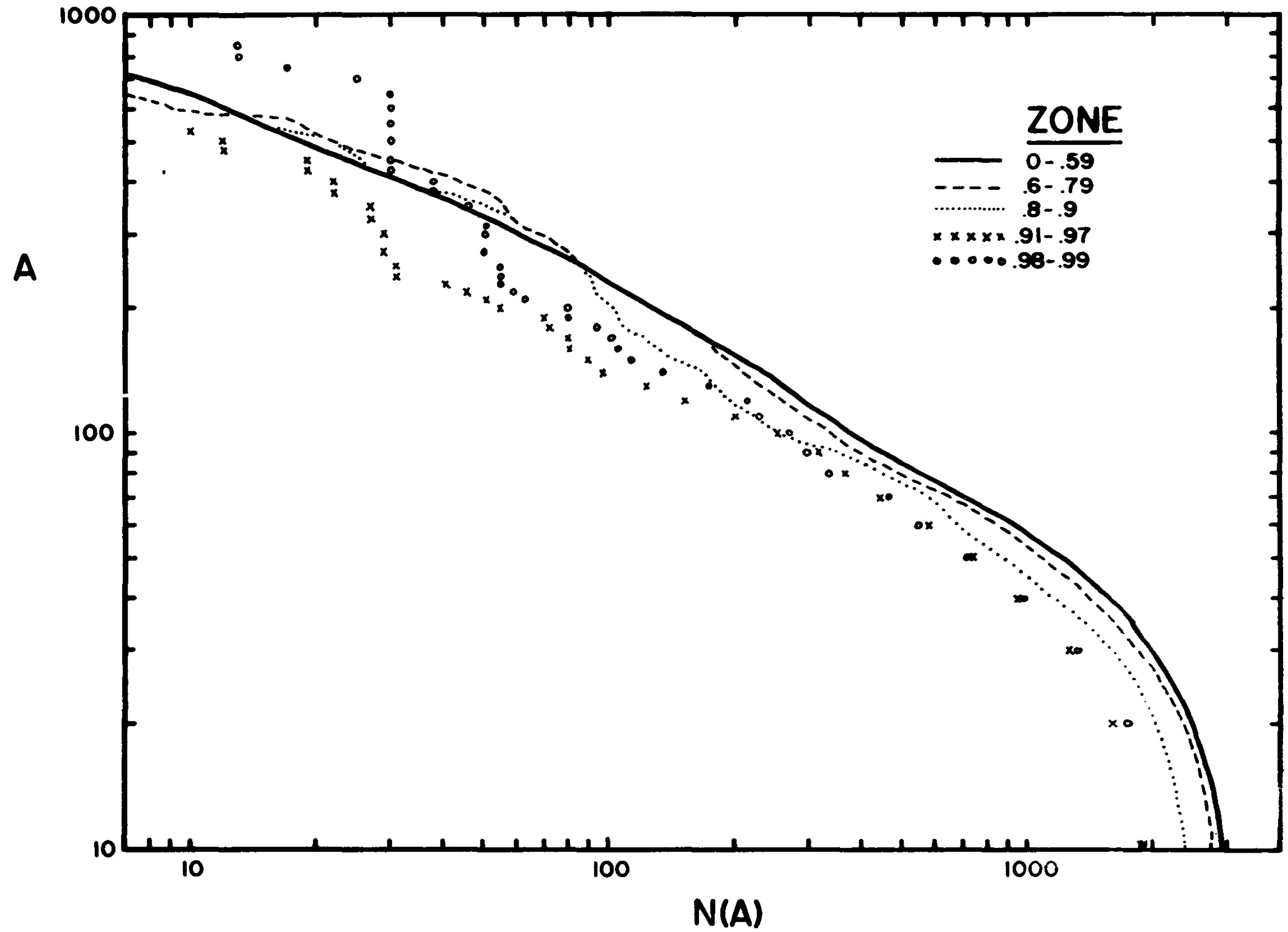

FIG. 8. Integral functions of graduated corrected areas.

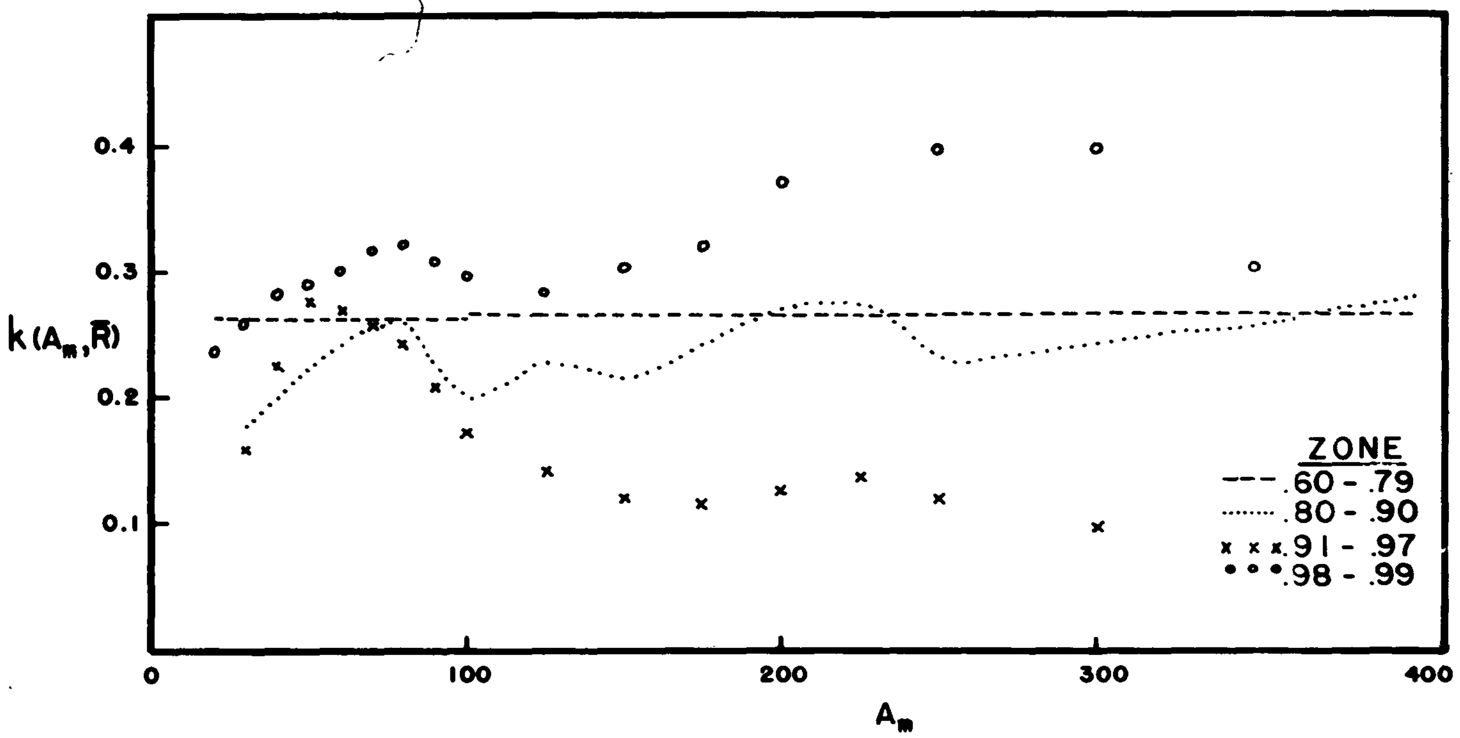

FIG. 9. Empirical determination of $k = A_\ell / A_p$.

Table 1

AREA LIMITS OF FLARE IMPORTANCE CLASSES
(Unit of millionths of the visible hemisphere or 1 heliographic square degree = 48.5m.)

Importance	Area Limits	
1-	< 100m	2°.06
1	100-250	2.06-5.15
2	250-600	5.15-12.4
3	600-1200	12.4-24.7
3+	> 1200	> 24.7

Table 2

BALLARIO'S CORRECTION FUNCTION $C_B(R)$
(FOR $R < 0.70$, $C_B = 1/\sqrt{1-R^2}$)

R	C_B
.70	1.387
.71	1.406
.72	1.412
.73	1.435
.74	1.441
.75	1.468
.76	1.476
.77	1.508
.78	1.531
.79	1.554
.80	1.579
.81	1.606
.82	1.636
.83	1.667
.84	1.701
.85	1.738
.86	1.778
.87	1.882
.88	1.869
.89	1.922
.90	1.983
.91	2.052
.92	2.131
.93	2.224
.94	2.265
.95	2.469
.96	2.629
.97	2.811
.98	3.084
.99	3.485
.995	3.821
1.000	4.475

Table 3

MALLARIO'S MEASURED AREAL LIMITS FOR IMPORTANCE CLASSIFICATION

R. V.	Subflares	Imp. 1	Imp. 2
0.1	100	248	600
0.2	98	245	590
0.3	95	238	575
0.4	92	230	550
0.5	87	215	520
0.6	79	200	480
0.7	72	180	430
0.75	66	165	400
0.8	62	155	375
0.85	58	145	350
0.9	52	125	310
0.925	47	115	280
0.95	42	105	255
0.975	34	85	215
1.0	13	55	135

Table 4

UNIFORM CORRECTION, C_w

R. V.	Corr.	R. V.	Corr.	R. V.	Corr.
.00	1.000	.350	.993	.700	1.170
.01	.998	.360	.995	.710	1.181
.02	.996	.370	.996	.720	1.193
.03	.994	.380	.999	.730	1.205
.04	.992	.390	1.001	.740	1.218
.05	.991	.400	1.003	.750	1.232
.06	.989	.410	1.005	.760	1.247
.07	.988	.420	1.008	.770	1.262
.08	.987	.430	1.011	.780	1.279
.09	.986	.440	1.014	.790	1.296
.10	.985	.450	1.017	.800	1.315
.11	.984	.460	1.020	.810	1.336
.12	.983	.470	1.023	.820	1.358
.13	.982	.480	1.027	.830	1.381
.14	.982	.490	1.031	.840	1.407
.15	.981	.500	1.035	.850	1.435
.16	.981	.510	1.039	.860	1.465
.17	.980	.520	1.043	.870	1.499
.18	.980	.530	1.046	.880	1.536
.19	.980	.540	1.053	.890	1.577
.20	.980	.550	1.058	.900	1.623
.21	.980	.560	1.063	.910	1.676
.22	.980	.570	1.068	.920	1.736
.23	.981	.580	1.074	.930	1.806
.24	.981	.590	1.080	.940	1.889
.25	.982	.600	1.087	.950	1.991
.26	.982	.610	1.093	.960	2.118
.27	.983	.620	1.100	.970	2.288
.28	.984	.630	1.107	.980	2.532
.29	.985	.640	1.115	.990	2.950
.30	.986	.650	1.123	.995	3.485
.31	.987	.660	1.132	1.0	5.000
.32	.988	.670	1.141		
.33	.990	.680	1.150		
.34	.991	.690	1.160		

Table 5

AREA CORRECTION FOR $A_m < 100$
by GRADUATED RECTIFICATION

R. V.	C_s	R. V.	C_s	R. V.	C_s
.00	1.000	.35	.950	.70	1.163
.01	.995	.36	.952	.71	1.175
.02	.991	.37	.954	.72	1.188
.03	.986	.38	.956	.73	1.202
.04	.982	.39	.959	.74	1.216
.05	.978	.40	.962	.75	1.231
.06	.974	.41	.964	.76	1.246
.07	.971	.42	.967	.77	1.263
.08	.967	.43	.971	.78	1.279
.09	.964	.44	.974	.79	1.297
.10	.962	.45	.978	.80	1.316
.11	.959	.46	.982	.81	1.335
.12	.956	.47	.986	.82	1.356
.13	.954	.48	.991	.83	1.377
.14	.952	.49	.995	.84	1.400
.15	.950	.50	1.000	.85	1.424
.16	.948	.51	1.005	.86	1.448
.17	.947	.52	1.011	.87	1.475
.18	.946	.53	1.016	.88	1.502
.19	.944	.54	1.022	.89	1.532
.20	.943	.55	1.028	.90	1.563
.21	.943	.56	1.035	.91	1.595
.22	.942	.57	1.042	.92	1.630
.23	.942	.58	1.049	.93	1.666
.24	.941	.59	1.056	.94	1.705
.25	.941	.60	1.064	.95	1.747
.26	.941	.61	1.072	.96	1.791
.27	.942	.62	1.084	.97	1.838
.28	.942	.63	1.092	.98	1.888
.29	.943	.64	1.098	.99	1.942
.30	.943	.65	1.108	.995	1.971
.31	.944	.66	1.118	1.000	2.000
.32	.946	.67	1.129		
.33	.947	.68	1.140		
.34	.948	.69	1.151		

Table 6a

MEASURED AREAS
DISTRIBUTION OF COUNTS

A \ R.V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
0-9	31.	14.	16.	9.	12.	17.
10-19	345.	203.	144.	167.	113.	137.
20-29	483.	307.	199.	177.	120.	122.
30-39	425.	255.	171.	121.	72.	80.
40-49	361.	224.	119.	79.	42.	51.
50-59	273.	122.	78.	65.	20.	30.
60-69	205.	123.	48.	38.	11.	24.
70-79	189.	97.	50.	23.	8.	17.
80-89	143.	70.	33.	33.	15.	10.
90-99	133.	58.	34.	22.	11.	10.
100-109	50.	34.	19.	13.	1.	9.
110-119	39.	21.	11.	9.	5.	7.
120-129	50.	22.	7.	4.	3.	2.
130-139	30.	16.	9.	1.	4.	3.
140-149	36.	13.	9.	6.	0.	3.
150-159	23.	11.	2.	7.	1.	3.
160-169	21.	7.	4.	4.	0.	0.
170-179	18.	8.	4.	2.	2.	2.
180-189	19.	10.	1.	0.	0.	5.
190-199	11.	12.	2.	0.	2.	1.
200-209	10.	6.	3.	0.	1.	1.
210-219	10.	4.	2.	2.	0.	1.
220-229	4.	5.	3.	1.	0.	1.
230-239	9.	1.	2.	0.	0.	3.
240-249	9.	2.	4.	2.	0.	1.
250-274	11.	9.	5.	2.	1.	2.
275-299	11.	3.	3.	2.	2.	0.
300-324	13.	3.	3.	1.	2.	0.
325-349	2.	4.	0.	0.	0.	0.
350-374	8.	4.	1.	0.	2.	0.
375-399	8.	3.	1.	0.	0.	1.
400-424	10.	6.	1.	0.	0.	0.
425-449	0.	3.	2.	0.	0.	0.
450-474	2.	0.	1.	1.	0.	0.
475-499	3.	1.	0.	0.	0.	0.
500-524	1.	1.	0.	0.	0.	0.
525-549	0.	2.	0.	0.	0.	0.
550-574	1.	1.	0.	0.	0.	0.
575-599	5.	3.	2.	0.	0.	0.

Table 6a (con't)

MEASURED AREAS
DISTRIBUTION OF COUNTS

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
600-649	2.	0.	0.	0.	0.	0.
650-699	1.	0.	0.	0.	0.	0.
700-749	1.	0.	1.	0.	0.	0.
750-799	1.	0.	0.	0.	0.	0.
800-849	0.	0.	0.	0.	0.	0.
850-899	0.	0.	0.	0.	0.	0.
900-949	0.	0.	0.	0.	0.	0.
950-999	2.	1.	0.	0.	0.	0.
1000-1049	2.	0.	0.	0.	0.	0.
1050-1099	1.	0.	0.	0.	0.	0.
1100-1149	0.	0.	0.	0.	0.	0.
1150-1199	1.	0.	0.	0.	0.	1.
≥1200	0.	2.	0.	0.	0.	3.

Table 6b

DISTRIBUTION BY PERCENTAGE, OF FLARES
WITH MEASURED AREAS $\geq$100

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
100-109	11.75%	15.59%	18.6%	22.8%	3.9%	18.4%
110-119	9.17	9.63	10.8	15.8	19.3	18.3
120-129	11.75	10.09	6.9	7.0	11.6	4.1
130-139	7.05	7.33	8.3	1.8	15.4	6.1
140-149	8.46	5.96	8.8	10.5	0.0	6.1
150-159	5.41	5.04	2.0	12.3	3.9	6.1
160-169	4.94	3.21	3.9	7.0	0.0	0.0
170-179	4.23	3.67	3.9	3.5	7.7	4.1
180-189	4.47	4.58	1.0	0.0	0.0	10.2
190-199	2.59	5.50	2.0	0.0	7.7	2.0
200-209	2.35	2.75	2.9	0.0	3.9	2.0
210-219	2.35	1.83	2.0	3.5	0.0	2.0
220-229	0.94	2.29	2.9	1.8	0.0	2.0
230-239	2.12	0.46	2.0	0.0	0.0	6.1
240-249	2.12	0.92	3.9	3.5	0.0	2.0
250-274	2.59	4.13	4.9	3.5	3.9	4.1
275-299	2.59	1.38	2.9	3.5	7.7	0.0
300-324	3.06	1.38	2.9	1.8	7.7	0.0
325-349	0.47	1.83	0.0	0.0	0.0	0.0
350-374	1.88	1.83	1.0	0.0	7.7	0.0
375-399	1.88	1.38	1.0	0.0	0.0	2.0
400-424	2.35	2.75	1.0	0.0	0.0	0.0
425-449	0.00	1.38	2.0	0.0	0.0	0.0
450-474	0.47	0.00	1.0	1.8	0.0	0.0
475-499	0.71	0.46	0.0	0.0	0.0	0.0
500-549	0.24	1.38	0.0	0.0	0.0	0.0
550-599	1.41	1.83	2.0	0.0	0.0	0.0
600-649	0.47	0.00	0.0	0.0	0.0	0.0
650-699	0.24	0.00	1.0	0.0	0.0	0.0
700-749	0.24	0.00	0.0	0.0	0.0	0.0
750-799	0.24	0.00	0.0	0.0	0.0	0.0
800-849	0.00	0.00	0.0	0.0	0.0	0.0
850-899	0.00	0.00	0.0	0.0	0.0	0.0
900-949	0.00	0.00	0.0	0.0	0.0	0.0
950-999	0.47	0.00	0.0	0.0	0.0	0.0
1000-1099	0.71	0.46	0.0	0.0	0.0	0.0
1100-1199	0.24	0.00	0.0	0.0	0.0	2.0
1200	0.00	0.92	0.0	0.0	0.0	6.1

Table 6c

DISTRIBUTION BY PERCENTAGE, OF FLARES
WITH MEASURED AREAS < 100

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
0-9	1.20	0.95	1.79	1.23	2.83	3.41
10-19	13.33	13.78	16.14	22.75	26.65	27.51
20-29	18.66	20.84	22.31	24.11	28.30	24.50
30-39	16.42	17.31	19.17	16.49	16.98	16.06
40-49	13.95	15.21	13.34	10.76	9.90	10.24
50-59	10.55	8.28	8.74	8.86	4.72	6.02
60-69	7.92	8.35	5.38	5.18	2.59	4.82
70-79	7.30	6.59	5.61	3.13	1.89	3.41
80-89	5.53	4.75	3.70	4.50	3.54	2.01
90-99	5.14	3.94	3.81	3.00	2.59	2.01

Table 7a

UNIFORM CORRECTION
DISTRIBUTION OF COUNTS

A \ R.V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
0-9	41.	12.	7.	0.	0.	0.
10-19	365.	180.	80.	11.	7.	3.
20-29	465.	234.	156.	79.	27.	1.
30-39	412.	256.	112.	100.	44.	12.
40-49	367.	202.	127.	78.	40.	9.
50-59	276.	151.	101.	83.	53.	24.
60-69	195.	103.	65.	79.	42.	23.
70-79	184.	107.	71.	55.	36.	56.
80-89	142.	91.	36.	46.	38.	24.
90-99	119.	70.	23.	37.	18.	10.
100-109	55.	47.	32.	31.	15.	48.
110-119	45.	34.	27.	22.	12.	13.
120-129	42.	26.	28.	17.	13.	25.
130-139	32.	18.	23.	16.	14.	12.
140-149	37.	20.	8.	19.	10.	19.
150-159	20.	11.	9.	15.	3.	24.
160-169	15.	7.	6.	12.	9.	9.
170-179	21.	11.	8.	8.	4.	24.
180-189	21.	6.	7.	11.	4.	6.
190-199	11.	12.	4.	9.	2.	13.
200-209	7.	9.	5.	7.	3.	19.
210-219	13.	10.	2.	5.	4.	11.
220-229	7.	11.	9.	9.	6.	9.
230-239	6.	3.	1.	2.	4.	4.
240-249	10.	5.	0.	1.	6.	8.
250-274	16.	8.	2.	16.	8.	7.
275-299	12.	7.	2.	4.	5.	13.
300-324	10.	5.	8.	5.	1.	14.
325-349	7.	1.	4.	1.	5.	10.
350-374	6.	3.	5.	0.	2.	9.
375-399	10.	5.	3.	0.	1.	8.
400-424	7.	3.	2.	3.	0.	6.
425-449	1.	4.	0.	0.	1.	3.
450-474	2.	3.	1.	1.	0.	8.
475-499	3.	2.	1.	2.	1.	2.
500-524	1.	2.	1.	1.	3.	8.
525-549	0.	0.	2.	2.	0.	1.
550-574	8.	0.	0.	3.	3.	6.
575-599	10.	3.	6.	3.	0.	5.

Table 7a (con't)

UNIFORM CORRECTION
DISTRIBUTION OF COUNTS

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
600-649	2.	1.	1.	0.	0.	3.
650-699	0.	1.	0.	1.	1.	2.
700-749	2.	1.	0.	0.	2.	3.
750-799	1.	0.	0.	0.	1.	0.
800-849	0.	0.	0.	0.	0.	2.
850-899	0.	0.	0.	0.	2.	5.
900-949	1.	0.	1.	1.	0.	1.
950-999	0.	0.	0.	0.	1.	1.
1000-1049	2.	0.	0.	0.	1.	1.
1050-1099	1.	0.	0.	0.	0.	1.
1100-1149	2.	0.	0.	0.	0.	0.
1150-1199	1.	0.	0.	0.	0.	2.
≥ 1200	0.	2.	0.	0.	0.	4.

Table 7b

DISTRIBUTION BY PERCENTAGE OF FLARES

WITH CORRECTED AREAS ≥100

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
100-109	12.32%	16.73%	15.38%	13.66%	10.2%	12.67%
110-119	10.08	12.10	12.98	9.69	8.2	3.43
120-129	9.41	9.25	13.46	7.49	8.8	6.60
130-139	7.17	6.41	11.06	7.05	9.5	3.17
140-149	8.29	7.12	3.85	8.37	6.8	5.02
150-159	4.48	3.91	4.33	6.61	2.0	6.34
160-169	3.36	2.49	2.88	5.29	6.1	2.38
170-179	4.70	3.91	3.85	3.52	2.7	6.34
180-189	4.70	2.14	3.37	4.85	2.7	1.58
190-199	2.46	4.27	1.92	3.96	1.4	3.43
200-209	1.57	3.20	2.40	3.08	2.0	5.02
210-219	2.91	3.56	0.96	2.20	2.7	2.90
220-229	1.57	3.91	4.33	3.96	4.1	2.38
230-239	1.34	1.07	0.48	0.88	2.7	1.06
240-249	2.24	1.78	0.00	0.44	4.1	2.11
250-274	3.58	2.85	0.96	7.05	5.4	4.49
275-299	2.69	2.49	0.96	1.76	3.4	3.43
300-324	2.24	1.78	3.85	2.20	0.7	3.70
325-349	1.57	0.36	1.92	0.44	3.4	2.64
350-374	1.34	1.07	2.40	0.00	1.4	2.38
375-399	2.24	1.78	1.44	0.00	0.7	2.11
400-424	1.57	1.07	0.96	1.32	0.0	1.58
425-449	0.22	1.42	0.00	0.00	0.7	0.79
450-474	0.45	1.07	0.48	0.44	0.0	2.11
475-499	0.67	0.71	0.48	0.88	0.7	0.53
500-549	0.22	0.71	0.96	1.32	2.0	2.38
550-599	4.03	1.07	2.88	2.64	2.0	2.90
600-649	0.45	0.36	0.48	0.00	0.0	0.79
650-699	0.00	0.36	0.00	0.44	0.7	0.53
700-749	0.45	0.36	0.00	0.00	1.4	0.79
750-799	0.22	0.00	0.00	0.00	0.7	0.00
800-849	0.00	0.00	0.00	0.00	0.0	0.53
850-899	0.00	0.00	0.00	0.00	1.4	1.32
900-949	0.22	0.00	0.48	0.44	0.0	0.26
950-999	0.00	0.00	0.00	0.00	0.7	0.26
1000-1099	0.67	0.00	0.00	0.00	0.7	0.53
1100-1199	0.67	0.00	0.00	0.00	0.0	0.53
≥1200	0.00	0.71	0.00	0.00	0.0	1.06

Table 7c

DISTRIBUTION BY PERCENTAGE OF FLARES

WITH CORRECTED AREAS < 100

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
0-9	1.60	0.85	0.90	0.00	0.00	0.00
10-19	14.22	12.80	10.28	1.94	2.30	1.85
20-29	18.12	16.64	20.05	13.96	8.85	0.62
30-39	16-06	18.21	14.39	17.67	14.43	7.41
40-49	14.30	14.37	16.32	13.78	13.12	5.56
50-59	10.76	10.74	12.98	14.67	17.38	14.82
60-69	7.60	7.33	8.35	13.96	13.77	14.20
70-79	7.17	7.61	9.12	9.37	11.80	34.57
80-89	5.53	6.47	4.63	8.13	12.46	14.82
90-99	4.64	4.98	2.96	6.54	5.90	6.17

Table 8a

GRADUATED CORRECTION
DISTRIBUTION OF COUNTS

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
0-9	88.	51.	15.	5.	0.	0.
10-19	490.	272.	145.	123.	44.	17.
20-29	455.	294.	184.	143.	96.	81.
30-39	430.	257.	170.	124.	80.	57.
40-49	354.	189.	119.	90.	63.	77.
50-59	270.	132.	83.	60.	38.	45.
60-69	206.	110.	41.	61.	19.	40.
70-79	150.	92.	52.	32.	30.	40.
80-89	152.	61.	37	22.	10.	31.
90-99	53.	35.	40.	27.	6.	20.
100-109	43.	26.	16.	21.	10.	19.
110-119	41.	22.	13.	20.	4.	11.
120-129	32.	17.	5.	12.	9.	14.
130-139	35.	7.	8.	11.	9.	10.
140-149	18.	12.	8.	3.	5.	9.
150-159	22.	7.	4.	4.	2.	8.
160-169	17.	9.	3.	0.	1.	6.
170-179	17.	7.	6.	3.	2.	4.
180-189	12.	8.	1.	1.	3.	8.
190-199	8.	10.	2.	6.	0.	2.
200-209	10.	4.	2.	2.	4.	7.
210-219	4.	8.	2.	2.	1.	2.
220-229	7.	2.	0.	2.	1.	3.
230-239	3.	5.	1.	4.	0.	1.
240-249	10.	1.	1.	0.	0.	2.
250-274	11.	5.	2.	1.	0.	2.
275-299	13.	6.	8.	0.	1.	4.
300-324	10.	6.	1.	1.	0.	0.
325-349	7.	1.	4.	0.	1.	1.
350-374	6.	3.	5.	2.	2.	2.
375-399	10.	5.	3.	0.	0.	3.
400-424	7.	3.	2.	1.	2.	0.
425-449	1.	4.	0.	0.	0.	0.
450-474	2.	3.	1.	3.	0.	0.
475-499	3.	2.	1.	0.	0.	1.
500-524	1.	2.	1.	1.	0.	1.
525-549	0.	0.	2.	2.	0.	2.
550-574	1.	1.	0.	0.	0.	2.
575-599	5.	5.	1.	1.	0.	2.

Table 8a (con't)

GRADUATED CORRECTION
DISTRIBUTION OF COUNTS

A \ R.V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
600-649	2.	1.	1.	0.	0.	1.
650-699	0.	1.	1.	0.	1.	0.
700-749	2.	1.	0.	0.	2.	1.
750-799	1.	0.	0.	0.	1.	1.
800-849	0.	0.	1.	0.	0.	0.
850-899	0.	0.	0.	0.	2.	0.
900-949	1.	0.	1.	1.	0.	0.
950-999	0.	0.	1.	0.	1.	3.
1000-1049	2.	0.	0.	0.	0.	1.
1050-1099	2.	0.	0.	0.	0.	0.
1100-1149	1.	0.	0.	0.	0.	0.
1150-1199	0.	0.	0.	0.	0.	0.
>1200	0.	2.	0.	0.	0.	3.

Table 8b

DISTRIBUTION BY PERCENTAGE OF FLARES
WITH CORRECTED ≥100

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
100-109	11.70%	13.26%	14.8%	20.2%	15.6%	14.0%
110-119	11.15	11.22	12.0	19.2	6.3	8.1
120-129	8.70	1.67	4.6	11.5	14.1	10.3
130-139	9.52	3.57	7.4	10.6	14.1	7.4
140-149	4.90	6.12	7.4	2.9	7.8	6.6
150-159	5.98	3.57	3.7	3.9	3.1	5.9
160-169	4.62	4.59	2.8	0.0	1.6	4.4
170-179	4.62	3.57	5.6	2.9	3.1	2.9
180-189	3.26	4.08	0.9	1.0	4.7	5.9
190-199	2.18	5.10	1.9	5.8	0.0	1.5
200-209	2.72	2.04	1.9	1.9	6.3	5.2
210-219	1.09	4.08	1.9	1.9	1.6	1.5
220-229	1.90	1.02	0.0	1.9	1.6	2.2
230-239	0.82	2.55	0.9	3.9	0.0	0.7
240-249	2.72	0.51	0.9	0.0	0.0	1.5
250-274	2.99	2.55	1.9	1.0	0.0	1.5
275-299	3.54	3.06	7.4	0.0	1.6	2.9
300-324	2.72	3.06	0.9	1.0	0.0	0.0
325-349	1.90	0.51	3.7	0.0	1.6	0.7
350-374	1.63	1.53	4.6	1.9	3.1	1.5
375-399	2.72	2.55	2.8	0.0	0.0	2.2
400-424	1.90	1.53	1.9	1.0	3.1	0.0
425-449	0.27	2.04	0.0	0.0	0.0	0.0
450-474	0.54	1.53	0.9	2.9	0.0	0.0
475-499	0.82	1.02	0.9	0.0	0.0	0.7
500-549	0.27	1.02	2.8	2.9	0.0	2.2
550-599	1.63	3.06	0.9	1.0	0.0	2.9
600-649	0.54	0.51	0.9	0.0	0.0	1.5
650-699	0.00	0.51	0.9	0.0	1.6	0.0
700-749	0.54	0.51	0.0	0.0	3.1	0.7
750-799	0.27	0.00	0.0	0.0	1.6	0.7
800-849	0.00	0.00	0.9	0.0	0.0	0.0
850-899	0.00	0.00	0.0	0.0	3.1	0.0
900-949	0.27	0.00	0.9	1.0	0.0	0.0
950-999	0.00	0.00	0.9	0.0	1.6	2.2
1000-1099	1.09	0.00	0.0	0.0	0.0	0.7
1100-1199	0.27	0.00	0.0	0.0	0.0	0.0
≥1200	0.00	1.02	0.0	0.0	0.0	2.2

Table 8c

DISTRIBUTION BY PERCENTAGE OF FLARES
WITH CORRECTED AREAS <100

A \ R. V.	.00-.59	.60-.79	.80-.90	.91-.97	.98-.99	1.00
0-9	3.32	3.42	1.69	0.73	0.00	0.00
10-19	18.50	18.22	16.37	17.90	11.40	4.17
20-29	17.18	19.69	20.77	20.82	24.87	19.85
30-39	16.24	17.21	19.19	18.05	20.73	13.97
40-49	13.37	12.66	13.44	13.10	16.32	18.87
50-59	10.20	8.84	9.37	8.73	9.85	11.03
60-69	7.78	7.37	4.63	8.88	4.92	9.80
70-79	5.66	6.16	5.87	4.66	7.77	9.80
80-89	5.74	4.09	4.18	3.20	2.59	7.60
90-99	2.00	2.34	4.62	3.93	1.55	4.90

Table 9

DISTRIBUTION BY IMPORTANCE CLASS
IN 6 ZONES OF APPROXIMATELY EQUAL AREA

Table 9a

MEASURED AREAS

	Counted Numbers				Percentages			
Zone	Imp. 1-	1	2	3	1-	1	2	3
.00-.59	2595	334	69	10	86	11	2.3	0.3
.60-.79	1480	166	40	3	88	10	2.4	0.2
.80-.90	894	82	17	2	90	8	1.7	0.2
.91-.97	733	51	5	1	93	6	0.6	0.1
.98-.99	425	22	6	0	94	5	1.3	0.0
.99	497	40	4	0	92	7	0.7	0.0

Table 9b

UNIFORM CORRECTION

.00-.59	2573	353	72	12	78	11	2.8	0.4
.60-.79	1402	232	47	8	83	14	2.8	0.5
.80-.90	772	183	34	6	78	18	3.4	0.6
.91-.97	574	183	29	4	73	23	3.7	0.5
.98-.99	305	114	27	7	67	25	6.0	1.5
.99	152	252	106	30	28	47	19.6	5.6

Table 9c

GRADUATED CORRECTION

.00-.59	2648	279	77	11	88	9	2.6	0.4
.60-.79	1493	145	46	5	88	9	2.7	0.3
.80-.90	886	72	31	5	89	7	3.1	0.5
.91-.97	687	91	12	1	87	12	1.5	0.1
.98-.99	386	51	6	7	86	11	1.3	1.6
.99	408	106	20	10	75	19	3.7	1.8

Table 10

DISTRIBUTION OF FLARES BY IMPORTANCE CLASS
IN 10 ZONES OF EQUAL RADIAL INCREMENT

Table 10a

MEASURED AREAS

	Counted Numbers				Percentages			
Zone	Imp. 1-	1	2	3	1-	1	2	3
.00-.09	35	3	4	0	83	7	9.5	0.0
.10-.19	156	22	4	2	85	12	2.2	1.1
.20-.29	365	44	7	2	87	11	1.7	0.5
.30-.39	617	58	19	2	89	8	2.7	0.3
.40-.49	702	108	18	1	85	13	2.2	0.1
.50-.59	720	109	17	3	85	13	2.0	0.4
.60-.69	743	75	20	0	89	9	2.4	0.0
.70-.79	737	91	20	3	87	11	2.4	0.4
.80-.89	801	73	15	2	90	8	1.7	0.2
.90-.99	1247	82	13	0	93	6	1.0	0.0
>.99	497	40	4	0	92	7	0.7	0.0

Table 10b

UNIFORM CORRECTION

.00-.09	38	2	4	0	86	5	9.1	0.0
.10-.19	155	23	5	2	84	12	2.7	1.1
.20-.29	366	42	8	2	88	10	1.9	0.5
.30-.39	617	58	17	4	89	8	2.4	0.6
.40-.49	698	101	20	1	85	12	2.4	0.1
.50-.59	699	127	21	3	82	15	2.5	0.4
.60-.69	701	114	20	3	84	14	2.4	0.4
.70-.79	701	118	27	5	82	14	3.2	0.6
.80-.89	695	162	30	5	78	18	3.4	0.6
.90-.99	954	319	61	10	71	24	4.5	0.7
>.99	152	252	106	30	28	47	19.6	5.6

Table 11

RELATIVE ZONAL AREAS
FOR VARIOUS DIVISIONS

Zone Limits	Included Area
0.0	
	0.00501
.1	
	0.01519
.2	
	0.02586
.3	
	0.03742
.4	
	0.05049
.5	
	0.06603
.6	
	0.08586
.7	
	0.11414
.8	
	0.16411
.9	
	0.29482
.99	
	0.14117
1.00	

Zone Limits	Included Area
0.00	
	0.00406
.09	
	0.01416
.19	
	0.02475
.29	
	0.04621
.39	
	0.04910
.49	
	0.05432
.59	
	0.08349
.69	
	0.11080
.79	
	0.15715
.89	
	0.31479
.99	
	0.14117
1.00	

Zone Limits	Included Area
0.0000	
	0.16667
.5528	
	0.16667
.7451	
	0.16667
.8660	
	0.16667
.9428	
	0.16667
.9860	
	0.16667
1.0000	

Zone Limits	Included Area
0.00	
	0.1715
.56	
	0.1771
.75	
	0.1683
.87	
	0.1513
.94	
	0.1328
.98	
	0.1990
1.00	

Zone Limits	Included Area
0.0000	
	0.20000
.6000	
	0.20000
.8000	
	0.20000
.9165	
	0.20000
.9798	
	0.20000
1.0000	

Zone Limits	Included Area
0.00	
	0.1926
.59	
	0.1943
.79	
	0.1742
.90	
	0.1986
.97	
	0.1102
.99	
	0.1301
1.00	

Table 12

FREQUENCY DISTRIBUTION OF FLARES IN HELIOGRAPHIC LATITUDE

$\|b°\|$	1957b	1960a	1960b	p(b)
0	0	4	2	.0021
1	0	3	4	
2	0	11	5	.0081
3	2	4	18	
4	4	13	21	.0219
5	7	13	18	
6	11	14	15	.0275
7	19	29	12	
8	21	56	26	.0575
9	32	64	22	
10	58	75	32	.0999
11	42	65	37	
12	60	65	23	.1030
13	52	67	20	
14	83	44	21	.1013
15	89	43	21	
16	71	24	18	.0939
17	70	17	29	
18	73	37	47	.0963
19	50	21	31	
20	45	24	67	.0840
21	35	13	22	
22	56	31	26	.0646
23	51	28	8	
24	60	17	8	.0607
25	40	14	10	
26	66	10	10	.0529
27	53	13	14	
28	38	12	10	.0494
29	16	12	5	
30	28	21	11	.0332
31	11	6	1	
32	21	10	5	.0184
33	14	9	0	
34	11	2	0	.0127
35	6	0	0	
36	4	2	0	.0042
37	5	0	0	
38	6	0	0	.0039
39	1	0	0	
40	0	0	0	.0004
41	6	0	0	
42	5	0	0	.0039
43	1	0	0	
44	0	0	0	.0004
45	1	0	0	

Table 13

ZONAL AREA PROJECTION FUNCTIONS

R=0.595

y	arcsin f(y)
.05	0.6356
.15	0.6216
.25	0.5915
.35	0.5394
.45	0.4510
.55	0.2288
.65	----

R=0.795

y	arcsin f(y)
.05	0.9180
.15	0.9102
.25	0.8937
.35	0.8664
.45	0.8240
.55	0.7578
.65	0.6464

R=0.905

y	arcsin f(y)
.05	1.1308
.15	1.1260
.25	1.1159
.35	1.0994
.45	1.0742
.55	1.0363
.65	0.9703

R=0.975

y	arcsin f(y)
.05	1.3464
.15	1.3441
.25	1.3392
.35	1.3313
.45	1.3193
.55	1.3014
.65	1.2741

R=0.995

y	arcsin f(y)
.05	1.4706
.15	1.4696
.25	1.4674
.35	1.4640
.45	1.4587
.55	1.4509
.65	1.4390

$g(y)=\sqrt{1-y^2}$

y	arcsin g(y)
.05	1.5208
.15	1.5195
.25	1.3181
.35	1.2132
.45	1.0403
.55	0.9884
.65	0.8632

Table 14

ZONAL INCIDENCE NORMALIZING FUNCTIONS

y \ R.V.	0.000 -0.595	0.595 -0.795	0.795 -0.905	0.905 -0.995	0.995 -1.000	p(y)
.05	.0350	.0155	.0117	.0119	.0068	.0550
.15	.1470	.0683	.0510	.0516	.0297	.2365
.25	.1849	.0944	.0694	.0698	.0401	.3125
.35	.1099	.0666	.0475	.0473	.0270	.2038
.45	.0669	.0553	.0371	.0363	.0207	.1483
.55	.0083	.0192	.0101	.0096	.0054	.0363
.65	---	.0049	.0025	.0023	.0013	.0076
Σ	0.5520	0.3243	0.2293	0.2288	0.1310	1.000

Table 15a

MEASURED AREAS
INTEGRAL FUNCTIONS

A \ R.V.	0.000 -0.595	0.595 -0.795	0.795 -0.905	0.905 -0.975	0.975 -0.995
0	3013	2878	2393	1908	1896
10	2982	2854	2354	1887	1846
20	2637	2509	2008	1484	1370
30	2154	1986	1529	1057	864
40	1729	1552	1117	765	561
50	1368	1171	830	574	384
60	1095	963	643	417	299
70	890	754	527	326	253
80	701	589	407	270	219
90	558	470	327	191	156
100	425	371	246	138	110
110	375	313	200	106	105
120	336	277	173	84	84
130	286	240	156	75	72
140	256	213	135	72	55
150	220	191	113	58	55
160	197	172	108	41	51
170	176	160	99	31	51
180	158	146	89	27	42
190	139	129	87	27	42
200	128	109	82	27	34
210	118	99	75	27	30
220	108	92	70	22	30
230	104	83	63	19	30
240	95	82	58	19	30
250	86	78	48	14	30
275	75	63	36	10	25
300	64	58	29	5	17
325	51	53	22	2	8
350	49	46	22	2	8
375	41	39	19	2	0
400	33	34	17	2	0
425	23	24	14	2	0
450	23	19	10	2	0
475	21	19	7	0	0
500	18	17	7	0	0
525	17	15	7	0	0
550	17	12	7	0	0
575	16	10	7	0	0

Table 15a (con't)

MEASURED AREAS
INTEGRAL FUNCTIONS

A \ R.V.	0.000 -0.595	0.595 -0.795	0.795 -0.905	0.905 -0.975	0.975 -0.995
600	11	5	0	0	0
650	9	5	0	0	0
700	8	5	0	0	0
750	7	5	0	0	0
800	6	5	0	0	0
850	6	5	0	0	0
900	6	5	0	0	0
950	6	5	0	0	0
1000	4	3	0	0	0

Table 15b

UNIFORM CORRECTION
INTEGRAL FUNCTIONS

A \ R.V.	0.000 -0.595	0.595 -0.795	0.795 -0.905	0.905 -0.975	0.975 -0.995
0	3012	2897	2373	1918	1905
10	2971	2851	2357	1918	1905
20	2606	2544	2164	1892	1875
30	2141	2146	1789	1701	1762
40	1729	1711	1519	1460	1576
50	1362	1367	1213	1271	1408
60	1086	1110	970	1071	1184
70	891	934	814	881	1007
80	707	752	643	748	856
90	565	597	556	637	695
100	444	478	501	548	620
110	391	398	424	473	556
120	346	346	359	420	506
130	304	296	291	379	451
140	272	266	236	340	392
150	235	231	217	294	350
160	215	213	195	258	337
170	200	201	181	229	299
180	179	182	161	210	282
190	158	172	144	183	266
200	147	151	135	162	257
210	140	136	123	145	244
220	127	119	118	133	228
230	120	100	96	111	203
240	114	95	94	106	185
250	104	87	94	104	160
275	88	73	89	65	126
300	76	61	84	55	105
325	66	53	65	43	101
350	59	51	55	41	80
375	53	46	43	41	72
400	43	37	36	41	67
425	36	32	31	34	67
450	35	26	31	34	63
475	33	20	31	31	63
500	30	17	26	27	59
525	29	14	24	24	46
550	29	14	19	19	46
575	21	14	19	12	34

Table 15b (con't)

UNIFORM CORRECTION
INTEGRAL FUNCTIONS

A \ R.V.	0.000 -0.595	0.595 -0.795	0.795 -0.905	0.905 -0.975	0.975 -0.995
600	11	9	5	5	34
650	9	7	2	5	34
700	9	5	2	2	30
750	7	3	2	2	21
800	6	3	2	2	17
850	6	3	2	2	17
900	6	3	2	2	8
950	5	3	0	0	8
1000	5	3	0	0	4

Table 15c

GRADUATED AREAS
INTEGRAL FUNCTIONS

A \ R.V.	0.000 -0.595	0.595 -0.795	0.795 -0.905	0.905 -0.975	0.975 -0.995
0	3015	2875	2393	1908	1896
10	2927	2788	2357	1896	1896
20	2437	2325	2008	1600	1711
30	1982	1825	1565	1255	1306
40	1552	1387	1155	955	969
50	1198	1065	869	738	704
60	928	841	669	594	544
70	722	654	571	446	464
80	572	497	445	369	337
90	420	393	356	316	295
100	367	334	260	251	270
110	324	289	221	200	228
120	283	252	190	152	211
130	251	223	178	123	173
140	216	211	159	97	135
150	198	191	140	89	114
160	176	179	130	80	105
170	159	163	123	80	101
180	143	151	108	72	93
190	130	138	106	70	80
200	122	121	101	55	80
210	112	114	96	51	63
220	108	100	91	46	59
230	101	97	91	41	55
240	98	89	89	31	55
250	88	87	87	31	55
275	77	78	82	29	51
300	64	68	63	29	51
325	54	58	60	27	51
350	47	56	51	27	46
375	41	51	39	22	38
400	31	43	31	22	38
425	24	37	26	19	30
450	23	31	26	19	30
475	21	26	24	12	30
500	18	22	22	12	30
525	17	19	19	10	30
550	17	19	14	5	30
575	16	17	14	5	30

Table 15c (con't)

GRADUATED AREAS
INTEGRAL FUNCTIONS

A \ R.V.	0.000 -0.595	0.595 -0.795	0.795 -0.905	0.905 -0.975	0.975 -0.995
600	11	9	12	2	30
650	9	7	10	2	30
700	9	5	7	2	25
750	7	3	7	2	17
800	6	3	7	2	13
850	6	3	5	2	13
900	6	3	5	2	4
950	5	3	2	0	4
1000	5	3	0	0	0

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A STUDY OF SACRAMENTO PEAK FLARES, II: FLARE AREAS AND IMPORTANCE CLASSIFICATION, by H. J. Smith and W. D. Booton, May 1961. 55pp. incl. illus. tables. (GRD Research Notes No. 58; AFCRL 472) Unclassified Report

The Sacramento Peak flare observations provide an ideal sample of data with which to study the distribution of solar flare areas and the effects of geometric projection upon the area. A flare's area is significant chiefly as a measure of its importance as a source of corpuscular emission and hard radiation. The present international convention of assigning importance is criticized, and some proposals to improve this convention are commented upon. The principal difficulty lies in the method of correcting the apparent area of a flare for geometrical foreshortening when the flare is not situated at the center of the solar disk. The majority of flares have some extension in height which is not (over)

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We have examined the statistical properties of the areas of 7500 flares and subflares in order to test other correction procedures, which take into account the sensible heights of flares. Our criterion of any area rectification process is that it should render the area frequency function of flares invariant with central distance. One procedure, which was devised by C. S. Warwick and has been adopted by several American observatories, proves to be very successful. However no objective formula can recover the area of a partially occulted flare right at the sun's limb. For such events an experienced observer's judgment is probably the best guide to a flare's importance.

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